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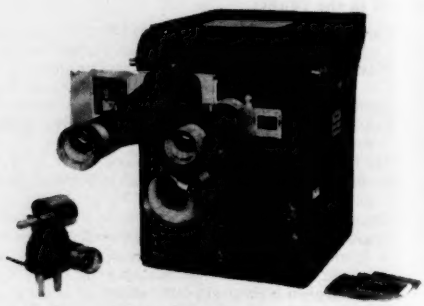

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SECURITY REGULATIONS AND THE CIVIL SERVICE

AN outstanding feature of the Geneva Conference last August on the peaceful uses of nuclear energy was the extent to which it restored the old spirit of scientific co-operation. Dr. A. H. Snell, director of the Physics Division of the Oak Ridge National Laboratory, for example, in his "Geneva Diary" in the *American Scientist*, recorded the opinion that the inhibitions of secrecy are no longer a controlling factor but are vestigial, and have been replaced by mutual scientific respect and by a sense that everybody is working on the same big job. Prof. I. I. Rabi, in expressing his own satisfaction with the results of the Conference in re-establishing the world-wide community of scientists, quoted a speech made to Hungary over the Moscow radio by Prof. V. Veksler to much the same effect, and noting the incentive for the mutual exchange of views that the Conference has given.

The significance of this Conference in re-establishing the contact between scientists and the conditions for the exchange of ideas upon which scientific advance depends is thus widely appreciated by scientists in all countries. It would appear, however, from the Prime Minister's very cold and reserved statement in the House of Commons on November 22, that political circles have yet to appreciate the importance of such freer interchange of views and of knowledge, not only from the point of view of scientific and technical advance, but equally from the point of view of preventing waste and duplication of effort. There is, it is true, still much to be done in this respect, and scientists generally could use the success of the Conference to illustrate the importance of freedom of discussion and of exchange of information as providing an essential condition for unimpeded scientific advance and for the most effective use of man-power and materials.

That aspect has been kept well to the fore in much that has been written on the security issue in the past ten years. It is well put, for example, in a symposium of papers on "Internal Security and Civil Rights" published in the *Annals of the American Academy of Political and Social Science* last July, particularly in those of Dr. R. M. Hutchins on the meaning and significance of academic freedom and of Prof. M. S. Livingston on science and security. With Dr. H. Tayler's account of the dismissal of professors who, invoking the Fifth Amendment, refuse to answer political inquiries in public, they help British readers to a clearer understanding of some puzzling incidents in the United States, as well as setting the whole question of science and academic freedom and security in its proper perspective.

This symposium is particularly welcome at a moment when the debates in Parliament on the disappearance of the former Foreign Office officials, Burgess and Maclean, and the subsequent appointment, announced by the Prime Minister on November 23, of a Conference of Privy Councillors to consider security precautions, brought security measures and secrecy again to the front in Great Britain. If, for example, there is to be any relaxation of secrecy in the field of nuclear energy, there must not only be public understanding of the value and importance of such relaxation, but equally public confidence that the precautions against disregard of what secrecy or security measures are retained are adequate and effective. The Conference, which includes the Lord President of the Council and six other members, is to examine the security procedures now applied in the public services of Britain and to consider whether any further precautions are called for and should be taken.

Much of the investigation of this Conference must obviously remain secret, though the Prime Minister said that any recommendations involving changes in the law would be referred to the House of Commons. It was the more unfortunate, accordingly, that neither in the debate in the House of Commons on November 7, nor in that in the House of Lords on November 22, were the wider issues really discussed. While the debates did something to remove public misgivings about the British security system, they were over-occupied with personal and transient aspects of the unhappy episode. The Foreign Secretary, Mr. Harold Macmillan, indeed stated that a regular system of positive vetting has been introduced in all Government departments having access to classified material involving the security of the State, and that in the Foreign Office the practice goes far beyond the recommendation of the committee appointed by the Foreign Secretary, immediately after the disappearance of Maclean and Burgess, to look into all aspects of the security arrangements in the Foreign Office. Not only all members of the senior branches and the senior grades of the junior branches of the Foreign Service are covered, but also many more junior grades who are inevitably employed on highly classified work. The committee, moreover, considered that character as well as political reliability should be assessed, and fresh instructions to that effect had been issued by the Permanent Under-Secretary of the Foreign Office to heads of missions and other senior officials before the committee reported.

Mr. Macmillan was emphatic that there could be no doubt of the skill, perseverance and loyalty of the Security Service, and that we had been able to recruit men of remarkably high character and attainments. He doubted whether any substantial further improvements in our security arrangements could be made within our existing system of law; but recognized that this and other incidents in the world of science have had a serious effect upon our reputation abroad. He said it is of the greatest importance that confidence should be felt that successive Governments have taken all steps within their power to stop any loopholes and to strengthen any legitimate methods of defending the vital secrets of the country.

Mr. Macmillan, in concluding, pointed out the real difficulty in this new situation that confronts us, of

reconciling security with the maintenance of a free society in the face of enemies who recognize no restraints. In the effort to preserve tolerance in the face of intolerance, it is all too easy to destroy freedom. As the Prime Minister said, it is probably true that if the Security Service had the powers which are possessed by such services in other countries, Burgess and Maclean would not be where they are to-day. Sir Anthony Eden added that he is not prepared to be Prime Minister of a Government which would ask for such powers of the House. Mr. Alfred Robens, who had reminded the House specifically that the attitude of our allies, and particularly of the United States, to the exchange of atomic secrets is conditioned by the degree of their confidence in our security arrangements and our ability to ensure that secrets entrusted to us will not pass to a foreign Power because of the laxity or inefficiency of our Security Services, agreed that we want security without McCarthyism. None the less, neither the Prime Minister nor the Foreign Secretary really faced the issue over passports, and any legal uncertainty should have made action easier rather than otherwise.

It is on this point that doubts have arisen as to the vigilance of the Foreign Office, on which some rather extreme and ill-judged criticism has been founded. It has been argued that issue of a passport is a privilege, not a right, and that a privilege can be withdrawn at the discretion of the Government. In particular, it has been suggested that those occupying posts involving access to highly secret information should be required to surrender their passports, which would only be available to them on notification of their intention to proceed overseas. During wartime, some procedure of this kind could well be formulated which would not restrict freedom of movement but merely ensure that those engaged in certain categories of work gave prior notification to a responsible officer of their intention to go abroad; but clear thinking on this matter is essential. The general issue is well put by J. A. Fanelli in an article, "Passport—Right or Privilege", contributed to the symposium already mentioned. Mr. Fanelli would make passports a right for every citizen—not sought by legal process; but while he condemns the present practice in the United States, which has been the subject of weighty protests so far as scientists are concerned, he would not object presumably to such a process as that just suggested. Incidentally, in Great Britain, as was pointed out by the Minister of State for Foreign Affairs on November 1, in theory, the Foreign Secretary has the power to withhold or withdraw a passport at his discretion.

The issue is one on which scientists themselves should be thinking constructively. Stray references in the debate in Parliament showed that members were thinking of scientists in relation to security, and that it was recognized as important to take the same care in vetting for employment in secret research work in industry as for employment in the Government service. Such requirements have to be reconciled, moreover, with the maintenance of the conditions under which a scientist, and especially the research worker, can give of his best, and secure stimulating contact with other minds. What matters above all at the moment in regard to this issue of security and secrecy in relation to science is that the right questions should be asked—the questions which scientific advance no less than the national security suggest.

Those questions are well indicated both by Dr. Hutchins and by Prof. Livingston, and their papers are not the less relevant in the discussion of British security measures in that those measures have avoided the grosser errors of which they, and other contributors to the symposium, complain. It is difficult for the non-scientist to keep clearly in mind in this context the way in which progress and leadership in science and national security alike depend on the number and quality of trained minds we can command, or to appreciate that because our intellectual potential provides the greatest security as well as our major resource, to secure the conditions which foster imaginative thinking is as important an element in defence policy as in research policy. Further, to carry restrictive conditions to a point beyond the indispensable minimum not merely hinders such thinking but may also endanger security by discouraging the recruitment of the very type of mind most required.

That we need reliable people in positions of responsibility and especially in secret investigations is obvious; but much keener thinking about the purposes of a security system and the way it functions is desirable than was manifest in either debate in Parliament. Moreover, the references to recruitment never touched on the real issue—the effect of security procedures on the recruitment of men and women of the character and ability most desirable in the service of the State. If we fail to put the proper emphasis on competence, and if independent thought and criticism are at a discount, we may get government servants who are loyal, but we may not get with that loyalty either the enterprise or the competence and vision that to-day are supremely important for the maintenance of national security.

Nor does the report of the Royal Commission on the Civil Service* really discuss this factor. The Commission was, indeed, limited by its terms of reference to the consideration of the principles which should govern pay, but including such matters as hours of work, payment for extra duty, annual leave, etc. It recognizes clearly that these conditions did not permit it to explore or comment upon ways in which recruitment might be improved and the Service made more attractive to possible recruits. None the less, the Commission points out that career prospects bear closely on the recruitment of suitable staff, and it is remarked that a review of recruitment procedures might indicate possibilities of improving the present situation. In the face of the competition, on which some comment was made in evidence to the Commission, it is obvious that the time a candidate sometimes has to wait before he is offered a post loses the Service many desirable candidates, and it may well be that this is one factor contributing to the acute

* Report of the Royal Commission on the Civil Service, 1953–55. Pp. viii+238. (Cmd. 9613.) (London: H.M. Stationery Office, 1955.) 6s. 6d. net.

recruitment difficulty of which the Atomic Energy Authority also complained in its first annual report.

Apart from its bearing on this question of recruitment generally and the effect on the quality of the candidates who present themselves, the report of the Royal Commission on the Civil Service makes little direct contribution to this security issue. The primary principle laid down by the Commission, that Civil Service pay should be based on a "fair comparison with the current remuneration of outside staffs employed on broadly similar work, taking account of differences in other conditions of service", is the only sensible principle. The public service, by its nature, cannot provide its own criteria of what is reasonable remuneration; and the standing advisory committee of distinguished men chosen to reflect a cross-section of informed opinion in the country, recommended by the Commission to advise the Government on the remuneration of the higher Civil Service, should help to avoid the danger of setting standards from within —a practice which the Commission rejects for the scientific class, in spite of the arguments of the Institution of Professional Civil Servants.

The evidence as to the effect of conditions in the Civil Service on recruitment is not altogether clear. The members concerned in the administrative class are too small to be assessed significantly in such a sample inquiry as that recently conducted by Political and Economic Planning, which suggested that the Civil Service is still obtaining, and holding, a reasonable proportion of university graduates, though possibly a lesser proportion of the first-class men than enter the Scientific Civil Service. The Civil Service Commissioners themselves, while considering that the quality of the successful candidates continues in general to be satisfactory, doubted whether the number of really outstanding candidates is quite sufficient for future needs, and would welcome another three or four such candidates a year. This view was generally endorsed by the departmental witnesses; and in the view of the Association of First Division Civil Servants, not enough of the ablest people from the universities are now entering the Service.

The opinion was expressed in evidence that the Civil Service does not require more than about twelve outstanding men a year. These should easily be obtained from the universities if reasonable conditions are offered; but it should also be remembered that, particularly as regards the scientific officer class, it is not in the country's interest that the Civil Service should attract more than a reasonable proportion of the scientific and technical talent of the nation. This was clearly recognized by the Commission, which stressed the importance of preserving as much flexibility as possible for complements in this field. Moreover, it emphasized the importance of adequate opportunities for such staff to transfer to administrative posts, both from the point of view of career, and as a means of ensuring that those responsible for policy are fully competent to appreciate the technical issues involved in its formulation.

That in itself has some bearing on the security issue, if secrecy procedures are to be formulated on a realistic basis, and will also be of increasing importance if the Civil Service is not to lag behind outside employment in the attractiveness of the scientific or professional career it can offer. It is also a prime safeguard in ensuring that there is a reasonable balance in the interchange between the Service and industry, over which the Ministry of Supply in particular is disturbed. Some such interchange is desirable, but the Ministry of Supply thought that superior financial inducements outside had led to excessive loss of senior men. The Commission was, however, strongly impressed by the view of the Barlow Committee that the best scientific men should have equal prospects of pay and promotion with the best men in the administrative class, at least up to the top of the principal grade. The chairman of the Interdepartmental Scientific Panel thought that the present position whereby the average man reached the grade of principal scientific officer by age thirty-six and the really first-class man at thirty to thirty-two was about right, but that the present proportion of posts above that grade was inadequate. He also suggested that while the special-merit promotion scheme was an outstanding success, and catered sufficiently for the exceptionally able research worker whose bent did not lie towards administration, more flexibility was desirable to enable the Service to retain people with administrative initiative and ability.

The Secretary of the Department of Scientific and Industrial Research also expressed the view that the disparity in career values between the administrative and scientific officer class should be reduced, and that some posts now in the deputy chief scientific officer grade would justify chief scientific officer grading. The Commission suggests alternative salaries rather than one figure for the chief scientific officer class, and sees no objection to increasing the number of posts in the scientific officer class with the same salary as the permanent secretary. It believes, however, that the position in the Service at the present time reflects that in outside employment generally, in that the comparatively small number of outstanding scientists are enabled to advance rapidly, while most men of average quality do not get much beyond a level of responsibility corresponding roughly to that of principal scientific officer.

This view finds some support in the recruitment position for, while the number of suitable candidates was below demand, the real vacancies were fewer in 1954 than in 1952 or 1953, varying according to subjects. There were more than sufficient applications from organic chemists and from biologists, but there was a nation-wide shortage of physicists and engineers. The Civil Service Commissioners believe that while the ablest scientists still make their career at the universities, of those just below the highest quality the Government recruits at least a fair share, that the standard of applicants is improving, and that in the next five years the Departments will obtain suitable men for a high proportion of their demands. Such recruitment difficulties as existed are ascribed to the national situation rather than to service conditions.

These views were generally endorsed by witnesses from the main departments employing scientific staff, and in this context the acute difficulty of which the Atomic Energy Authority complained in its first annual report may be a passing phase. The Authority, in fact, has rather more flexibility in regard to salaries than the Civil Service, and it is inconceivable that it is offering less attractive conditions in regard to equipment and the like than other Government establishments. These conditions, in fact, frequently give the Government service a considerable advantage with the research worker over other bodies or industrial firms, particularly if there is any substance in the view frequently expressed that an industrial career does not give the same prestige as an academic career with outstanding research work.

One possible explanation may be the severe screening to which many of the Atomic Energy Authority's staff are subjected. This inevitably reduces the number of eligible candidates, and apart from deterring some who would be eligible, the delay involved may lead to others taking employment elsewhere. The point is worth considering, for it is not only in work on nuclear energy that it is desirable to keep secrecy requirements and screening investigations to the indispensable minimum. The Conference of Privy Counsellors is charged with seeing that security measures in Britain are adequately conceived and effectively operated. It is no less important to see that they are wisely applied, and that they are not allowed to obstruct the nation's economy by being used where no real purpose is served. The restoration of confidence in the security measures operating in Great Britain and abroad is not simply a matter of seeing that they are adequate and are efficiently operated. It is no less a matter of seeing that they are limited to their proper field, and that the lines between military and non-military work on nuclear energy, for example, are drawn as clearly as possible. The philosophy which inspires the whole security system should be one which keeps secrecy in its proper place, and makes it the servant and not the master of policy, placing its reliance not on negatives but on the positive contributions which imaginative, alert and creative thinking make to our economy as well as to our system of defence. The remuneration offered in the Civil Service is still one factor which determines the power to attract recruits of the character as well as of the intellectual ability which that Service demands.

THE PHILOSOPHY OF NATURAL PRODUCT CHEMISTRY

The Structural Relations of Natural Products

Being the First Weizmann Memorial Lectures, December, 1953. By Sir Robert Robinson. Pp. xii+150. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 25*s*. net.

THIS is a remarkable little book. Its distinction is twofold. First, it is, so far as I am aware, the first book that has been written by Sir Robert Robinson. Secondly, it represents the first series of Weizmann Memorial Lectures delivered at the Weizmann Institute, Rehovoth, in memory of Israel's late President.

Dr. Chaim Weizmann was widely respected for his scientific work, not only in Israel but also in all countries of the world where the science of organic chemistry is seriously pursued. An introduction to the volume under review by Dr. E. Katchalski, the present director of the Weizmann Institute, indicates something of the character of the man who is to be honoured in perpetuity and gives a glimpse of the respected place that science occupies in the new State of Israel. It need only be said that the first Weizmann Lectures are a worthy token of respect by one great man for another.

The main purpose of the book is to show how the constitutions of natural products can be broken down into smaller units. Once these smaller units have been recognized, they may be reassembled in different ways in order to provide structural formulæ which may, or may not, represent real natural products. The fundamental concept carries with it the implication that there is a relationship between the assembly of the hypothetical structural units and the real, but still largely unknown, processes of biosynthesis. It is somewhat paradoxical that the more complex the natural product the more easy it is, in general, to discern the structural units from which it is composed. It is largely for this reason that 'biogenetic concepts' have now become an important ancillary to more orthodox methods of elucidation of the constitutions of organic molecules.

The first lecture deals with the building up of fatty acids from C_2 residues, the modification of this scheme to include isoprene residues and the derived terpenoids and steroids, the development of carbohydrates and their congeners, the introduction of the C_6—C_3, the C_6—C_3—C_6 and the C_6—C_3—C_3—C_6 structural groups and some miscellaneous topics including mould products. The breadth of the field covered is such that no group of substances can be treated in any detail. Nevertheless, the integrating power of the method is so great, and Sir Robert's exposition so able, that the essential points are clearly presented. Any reader who is interested in, say, triterpenoid biogenesis will find the references that he needs to follow the full development of his speciality.

The application of 'biogenetic concepts' probably receives its finest expression in the field of alkaloid chemistry. It is in this branch of knowledge that Sir Robert's classical paper of 1917, describing the synthesis of tropinone, adumbrated clearly all subsequent developments. The second and third lectures present the various groups of alkaloids in order of increasing complexity. Again, it is the more complex compounds which tell us most about biogenetic pathways. For example, once the concept of the fission of the aromatic ring of 3 : 4-dihydroxyphenylalanine (or its equivalent) had been developed by Woodward to explain the biogenesis of strychnine, it was possible to correlate theoretically the strychnine and quinine groups of alkaloids. Furthermore, Sir Robert was even able to deduce the correct constitution for emetine. The achievements of the theory in alkaloid chemistry are indeed impressive.

The use of 'biogenesis' in the elucidation of the constitutions of organic molecules has had its critics, especially from the biological side. Nevertheless, it would seem philosophically improbable that such remarkable order as is presented in the book under

review should not have a real basis in Nature. No one pretends that the units written down by the organic chemist, or even used by him in syntheses under 'physiological conditions', are really present in the plant. All that is claimed is that the *equivalents* of these units are available. We are just now beginning to see the fruits of tracer experiments, which should do much to place 'biogenetic concepts' on an even firmer theoretical basis. There is no clash here between the organic chemist and his more biologically minded colleagues. Provided that constitutional arguments by 'biogenesis' are used as a stimulus to critical experimental work—not as a substitute therefor—the method has much to commend it.

This book can be thoroughly recommended to all mature organic chemists and others interested in the subject. It is a little unfortunate that a work which deserves to be read so widely should be so comparatively expensive. D. H. R. BARTON

CLASSICAL ELECTROMAGNETISM

Electromagnetic Theory

By Prof. V. C. A. Ferraro. Pp. viii+555. (London: The Athlone Press (University of London), 1954. Distributed by Constable and Co., Ltd.) 42*s*. net.

PROF. V. C. A. FERRARO'S book "has been written to meet the requirements of students reading for an Honours degree course in Mathematics . . . it should also be of use to physicists and electrical engineers". Four-fifths of the book is devoted to the steady state (including steady currents and their magnetic fields); this part contains chapters devoted to special topics such as systems of conductors, images and inversion, steady-current networks and boundary-value problems in potential theory. After the introduction of electromagnetic induction and the development of Maxwell's equations comes a chapter on alternating-current theory and two chapters on electromagnetic waves. The book closes with a chapter on the motion of charged particles in steady electric and magnetic fields. There are an extensive collection of examples at the end of each chapter and a number of worked examples in the text.

The balance of emphasis between static and varying fields, and the necessarily brief account given of the applications of the theory, suggest that the book should be appraised primarily as an exposition of the fundamental principles of electromagnetic theory. For this exposition the author adopts the traditional method, proceeding from the electromagnetic field in free space to the properties of dielectrics considered as regions of distributed polarization, and then to the magnetic fields of permanent magnets and magnetic materials. The theory of the magnetic fields of steady currents is developed from the properties of the circulation integral, and the connexion between electromagnetic induction and the conservation of energy is explained.

This approach to electromagnetic theory undoubtedly has many advantages. It enables the student to obtain a firm grasp of the physical significance of the electric and magnetic field-strength and induction vectors by studying their simplest manifestations; and this familiarity with the basic concepts facilitates the understanding of their rather complicated interconnexions in Maxwell's equations. On the whole, the author has exploited well the advantages of his choice of method, and the result is a readable and lucid text-book of classical electromagnetic theory. The book is open to criticism, however, on important points of detail. For example: the introduction of the displacement current is based on an apparently arbitrary preference by Maxwell for closed currents; the treatment of the energy density of the magnetic field, on which the deduction of the law of electromagnetic induction depends, proceeds by unjustified generalization, from a formula developed for permanent magnets in free space, to systems containing permeable media and electric currents; the proof of an important formula for the energy of a distributed current system is based on the statement, which is several times repeated in other contexts, that the stream lines in a solenoidal field are closed curves; and even in a theoretical text-book one does not expect to find such statements as that "molecules become electric dipoles only through the action of the inducing electric field", and that in iron the intensity of magnetization is directly proportional to the magnetic field. E. WILD

BRITISH MOSSES AND LIVERWORTS

British Mosses and Liverworts

An Introductory Work, with Full Descriptions and Figures of over 200 Species, and Keys for the Identification of all except the Very Rare Species. Written and Illustrated by Dr. E. Vernon Watson. Pp. xvi+419+18 plates. (Cambridge: At the University Press, 1955.) 45*s*. net.

THE need for a simple flora dealing with the British bryophytes has been felt for a long time. It is true that the identification of the British species is well provided for by the handbooks of Dixon and MacVicar; but the comprehensive detailed treatment which makes these works so valuable is apt to be confusing and even somewhat forbidding to the beginner. Dr. E. Vernon Watson has now produced a clear and attractive introductory flora, which should be a great asset to anyone commencing the study of British mosses and liverworts. It has naturally not been possible to include all the British species in this shortened account; but, by omitting the rarities, identification of the commoner species has been greatly facilitated.

The principal morphological features of mosses and liverworts are simply and clearly described in the introduction and glossary, which should enable the book to be used successfully even by those with little previous knowledge of the bryophytes. Although full descriptions and drawings are given for only 154 species of mosses and 55 species of liverworts, the keys and notes provide in all for the identification of 310 mosses and 136 liverworts. Several practical trials have shown that the keys are easy to follow and are based on readily determined characters. A few numbers have evidently been omitted accidentally from the key on p. 59, but any such errors should give little difficulty and are not easy to avoid in the first edition of a book of this type. The detachable field-key is an innovation of doubtful value. Since only the commonest species are included, its use is sure to lead to disappointment on many occasions.

In a number of respects the book is an improvement on previous bryophyte floras. The drawings of the species selected for detailed treatment are particularly valuable; and include habit drawings as well as figures of details important for identification. The descriptions are straightforward but sufficiently full, and are accompanied by useful ecological notes. Habitat lists at the end of the book indicate the range of species most likely to be encountered in twenty-five different habitats, and should be of great value to those beginning field-studies of the bryophytes. Mention should also be made of the fine photographs, which illustrate the attractive appearance of some of the common mosses and liverworts.

It may be said in conclusion that Dr. Watson has succeeded admirably in his aim of providing a sound introductory flora of the British bryophytes. The British student is now well provided with floristic works; but there is still a great need for an introductory work dealing with the more general aspects of bryology. Anyone acquainted with the classical works of Hofmeister, Leitgeb, Goebel and others, and with the many recent contributions to the morphology, physiology, cytology, genetics and general biology of the bryophytes, will realize that taxonomic studies are only one approach to the many aspects of bryological science. A. Allsopp

BLACK FLIES OF GUATEMALA

The Black Flies (Diptera, Simuliidae) of Guatemala and their Role as Vectors of Onchocerciasis

By Herbert T. Dalmat. (Smithsonian Miscellaneous Collections, Vol. 125, No. 1, Pub. 4173.) Pp. 425+44 pl. (Washington, D.C.: Smithsonian Institution, 1955.)

In the New World onchocerciasis is endemic in certain areas in Guatemala, Mexico, elsewhere in Central America, and in Venezuela. In communities within these areas in Guatemala, the degree of infection may vary from 5 to 100 per cent, with an average of about 35 per cent. About half those infected suffer from ocular symptoms, and about 5 per cent suffer the most serious *sequela*, namely, blindness. It has been estimated that some thirty-five thousand persons in Mexico and some twenty-five thousand in Guatemala are infected. As in Africa, the infecting worms are transmitted from man to man by species of Simuliidae. Nuisance caused by the biting flies can also bring to a halt field-operations, particularly the harvesting of coffee, which is the most important crop in the endemic areas of Guatemala. Prior to 1934 only three species of Simuliidae were known from Guatemala; that year Bequaert[1] added three more. To anyone acquainted with the Simuliidae and able to read maps, this was obviously a quite unrealistic picture of the Simuliid fauna in a country like Guatemala. This book by H. T. Dalmat presents the results of nearly six years (1947–53) of intensive work on the Simuliidae in Guatemala, done with the support of various agencies and the Ministry of Health there. Forty-one species are dealt with and, of these, thirteen are ones that Dalmat has described as new in the course of his studies in Guatemala in earlier papers.

The various species are described in detail: both sexes, the pupa with its cocoon, and the mature larva when, as in most cases, diligent field-work or controlled rearing has provided them. No new species are described; but there are descriptions of sexes and stages not previously known. Keys for identification of the species in all stages are provided, and there are excellent series of figures of genitalia, etc., all drawn in the same style from uniformly prepared parts. Uniformity of style and preparation is important because parts such as the male claspers can give very different impressions of their characteristics if snipped off the abdomen at slightly different angles. The keys are restricted to the species known from Guatemala, and one therefore wonders if there is much real value in giving a key to the sub-genera of *Simulium*. All that this key does is to pick out three species which are the only representatives of their different sub-genera in Guatemala and then lead on to other keys to the remaining species of the other four sub-genera represented in the Guatemalan fauna. Only the more important and more recent references for each species are given, and the reader is referred to Vargas's[2] catalogue of "New World Simuliidae" for the complete literature up to the date of that catalogue (1945). The status of genera and sub-genera is not discussed.

Valuable and important as these systematic descriptions are, the parts of the book that will interest Old World readers most are probably those dealing with epidemiology (pp. 6–57) and ecology (pp. 313–372). Anyone proposing to carry out a survey of Simuliidae would do well to study Dalmat's approach and methods. The various tables, graphs, etc., obviously represent but a creaming of a vast amount of data collected.

In certain regions the rainy season is inimical to Simuliidae because the exceptional amounts of water scour large numbers of larvæ and pupæ from their substrates and wash them down-stream to conditions under which, even if they could gain a foothold, they would not survive. The coffee crop is usually concentrated in small patches cleared in the forest. At harvest large numbers of workers go to these coffee fields, and men especially will expose the upper parts of the body and roll up their trouser legs when picking the berries. Furthermore, while picking berries, the workers stand relatively still in one place and so present excellent targets for the flies. If the harvest coincides with a good emergence of adult Simuliidae, then conditions are ideal for spreading the infection of onchocerciasis, for the adult flies will travel considerable distances to obtain a blood-meal.

Only three species of *Simulium* appear to be of importance as vectors of onchocerciasis in Guatemala: *ochraceum* Walker, *metallicum* Bellardi and *callidum* Dyar and Shannon. These three are markedly anthropophilic in habit compared with the remaining species. Itinerant peddlers are a feature of Guatemalan village life, and they may possibly be a source of infection. The exact factors that control endemicity are not yet apparent: the principal vector seems to be *S. ochraceum* Walker; but the areas of endemicity do not extend to the margins of the distribution of this species.

The Smithsonian Institution is to be congratulated on the general format and production of this book, in which it has been assisted financially by the Pan-American Sanitary Bureau. John Smart

[1] Bequaert, J. C., in Strong, R. P., Sandground, J. D., Bequaert, J. C. and Ochoa, M. M., "Onchocerciasis, with special Reference to the Central American Form of the Disease" (Dept. Trop. Med. and Inst. Trop. Biol. Med., Harvard Univ., Contr. No. 6, 234; 1934).

[2] Vargas, L., *Inst. Salubr. Enferm. Trop., Mexico*, No. 1 (1945).

COMBUSTION IN THEORY AND PRACTICE

By T. F. HURLEY, O.B.E.

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A CONFERENCE on the subject of combustion was held in June of this year in the United States at Boston under the auspices of the Institution of Mechanical Engineers and the American Society of Mechanical Engineers and repeated in London in October. At each meeting the same forty papers were presented and discussed, seventeen being of British or European origin and twenty-three American.

The main idea of the conference was first to link theory and practice in the sphere of combustion by presenting the results of theoretical work to practical engineers, and secondly to provide an opportunity for practical engineers to discuss the application of theory in the field of boilers, furnaces, internal combustion engines and gas turbines. On the whole, this theme was followed and was not lost to view in the mass of useful information of a practical nature which was also presented in the papers and discussed in both Boston and London.

For convenience of discussion, the conference was divided into six sessions, the first of which dealt with the chemistry and physics of combustion from the fundamental aspect and included an American paper on the appraisal of combustion research. This paper reviewed the history of the development of the art of combustion in a comprehensive manner, and the authors' reflexions in relation to the theme of the conference obviously had a marked influence upon the views which were expressed during the discussion.

The second, third, fourth and fifth sessions were concerned with papers on boilers, industrial furnaces, internal combustion engines and gas turbines, respectively. They were mainly, though not entirely, of a practical nature and dealt with such subjects as fuels of all types, the design of equipment, operating difficulties and experiences, and instrumentation.

The sixth and final session was used to summarize the previous five and was the only one in which the conference was divided into sections for the simultaneous discussion of different groups of papers. The fundamental papers were discussed in London, but not in Boston.

It was suggested in the general papers and generally agreed in the discussion that, in the field of combustion, basic theory and practice are far apart: the practical engineer has developed his full-scale equipment and methods empirically, as a result of experience rather than by the application of scientific data. When in difficulties he may call in the chemist or the physicist to explain new phenomena which he has encountered; but the function of the scientist should be to predict as well as to explain.

Various explanations were put forward: one being that through over-specialization the engineer and the scientist not only see the same thing from different angles but also speak different languages. The engineer should therefore learn to state his problem in a manner which would be understood by the scientist, while the latter should present his results in such a way that the engineer can readily see how to apply them in practice. Some authors and speakers advocated the use of middlemen or interpreters who could speak both languages, while others thought that, whenever possible, both large- and small-scale research and development should be carried out jointly by teams comprising, in the ideal case, engineers, chemists, physicists and mathematicians.

From a different aspect a minority pointed out that the chemistry of combustion is extremely complex, and the engineer is always under pressure to adapt plant quickly to suit new conditions. He may have only a limited knowledge of the details of the combustion mechanism but, nevertheless, especially in the older fields of application, he has ample knowledge of the conditions necessary to obtain, and maintain, a very high standard of thermal efficiency, and he has amply proved his ability to apply his knowledge.

Many of the papers, taken from all sections of the conference, amply demonstrate that in most practical applications combustion, in itself, does not present a major problem. In some cases the type of fuel used and the design of the combustion equipment are decided by the size of the plant, in some by maintenance problems or ease of control, and, in nearly all, by economic considerations. In each session emphasis was placed on the effects of impurities in the fuel, which are so important that combustion problems usually become apparent only when some such effect as temperature accentuates the difficulties caused by the presence of harmful elements such as sodium, sulphur or vanadium. In boilers the process of combustion is subordinate to considerations of heat transfer and the avoidance of bonded and other external deposits; in furnaces the life of the roof is all-important; in internal combustion engines the use of residual oils has brought up problems of abrasion and corrosion, which were discussed in detail; and in industrial gas turbines, although combustion problems are more important than in some other fields, the effect of impurities such as vanadium in residual oil is receiving much attention.

Although in the past the art of combustion may have developed more as a result of experience than by the application of fundamental data, the high rates of reaction and of heat-release which are demanded when burning fuel in the newer types of equipment, such as gas turbines and ram jets, bring much nearer the time when performance will be limited by the basic mechanism of the combustion process. Possibly for this reason great interest was shown in an American paper describing experiments to determine the maximum heat-release to be obtained by burning liquid hydrocarbons and to observe the conditions which limit reaction-rates. In these experiments it was found that, under certain specified conditions, the maximum heat-release was $3{\cdot}0 \times 10^6$ B.Th.U. per cu. ft. per hr. per $(\text{atm.})^{1{\cdot}8}$, and that in the final stages of combustion the oxidation of carbon monoxide was the slow controlling step.

For various practical reasons the maximum heat-release obtained in these experiments is more than

ten thousand times that employed in most modern water-tube boilers; but it was pointed out that heat-releases of the same order occur intermittently in internal combustion engines and a figure of several million B.Th.U. per cu. ft. per hr. was quoted for continuous combustion in gas turbines. The conclusion that the oxidation of carbon monoxide limits the maximum heat-release is consistent with British experiments showing that the combustion of carbon monoxide is inhibited by the presence of methane. It may also be in line with a statement that in the gas turbine most of the heat-release takes place in about one-third of the space used for combustion, the remainder being used for the combustion of hydrogen and carbon monoxide.

It must not be thought that, even with the older methods of combustion, progress has been made without the use of extensive research or without employing scientific methods of investigation. Thus some scientists would not regard work carried out on combustion under the rapidly changing conditions within the cylinder of an internal combustion engine as fundamental; but one paper described experiments in which the scientific method is used *inter alia* to examine the flame stability in an internal combustion engine by means of new electronic measuring devices. Similarly, much use is made of models to examine the influence of aerodynamic flow upon the combustion process in plant as divergent in construction as the open-hearth furnace and the gas turbine.

Mention may also be made of some of the other examples of applied research on combustion which were discussed at the conference. The high temperatures encountered in modern small-sized combustion chambers and the extended use of automatic control in the larger sizes have resulted in the development of many new measuring instruments. The radiation from the flames of solid, liquid and gaseous fuels is being studied by an international committee and, with each type of fuel, attempts are being made to correlate radiation with the progress of combustion. The chemical and physical properties of the ashes in various types of fuel are being studied intensely, not only with the object of reducing deposits on metal surfaces but also because of their limiting effect upon combustion conditions at high rates of heat-release. Experimental work is proceeding on the use of additives to influence the actual combustion process, as well as to reduce the effect of impurities upon deposits and upon wear and tear. Completeness of combustion is also being controlled to prevent deposits. As a final example, studies of aerodynamic flow in various types of combustion chamber are of outstanding interest on account of the influence of the flow pattern upon the conditions controlling combustion at any particular point and at any particular time.

Considering the complete conference in relation to its central theme, it would seem that the practical engineer has developed combustion techniques which have served their immediate purpose and which, in the past, have been good enough to make the actual process of combustion a minor problem. More recently, he has found it necessary to carry out intensive experimental work on closely associated phenomena; but he has not, so far, made much use of the fundamental chemistry and physics of the combustion mechanism. The conference clearly deplored this fact and supported the view that the time has arrived to take positive action to close the gap between theory and practice.

THE SCIENTIFIC STUDY OF PLANTS*

By Prof. H. E. STREET
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THE Department of Biology of University College, Swansea, was founded in 1921 under the direction of Dr. Florence A. Mockeridge; in 1936 she was elected its first professor of botany. Now the College is establishing separate Departments of Botany and Zoology and building new biological laboratories. The pioneer biologists at Swansea have faced, in some measure, that resistance which their subject has encountered at many points during its history; a resistance which arises because its impact on our dogmas and ways of life is more direct and profound than that of any other branch of science. There exists a widespread lack of understanding of the nature and importance of contemporary botany. It is therefore appropriate that I should endeavour to trace, in very broad outline, some of the main currents of its historical development.

Systematic Botany and the Concept of Evolution

Knowledge of the usefulness of plants is as old as man himself. It was not, however, until the rise of the Greek and Roman civilizations, and then primarily in connexion with the identification of medicinal plants, that systematic and detailed descriptions of plants were written down. From work of this kind originated the "Herbal" of Dioscorides, produced in the first century A.D.

The Dark Ages intervened between the fall of Rome and the Renaissance. Then came a renewal of interest in the form of living things as exemplified by the paintings of Botticelli and the drawings of Leonardo da Vinci, by the reproductions of the texts of the Ancients, by the publication of the sixteenth-century herbals, by the anatomical studies of Harvey, and by the founding of learned societies like the Royal Society. It was at this time that botanic (physic) gardens were established in the ancient universities of Europe, and that explorers first brought to Europe many of the food plants we know to-day.

Stimulated by Bacon's dictum that the essential first step for scientific progress is the accumulation of facts, and aided by Boyle's introduction (1663) of alcohol as a preservative, there arose during the eighteenth century a group of naturalists which included Tournefort in France and John Ray in Cambridgeshire. They not only collected and described plants, but also sought to classify them into

* Substance of an inaugural lecture delivered on October 27 at the University College of Swansea.

species, genera and families. They recognized not only distinct species (a unit introduced by Aristotle) but also resemblances and affinities between them. This work formed the basis for the "Systema Naturae" of Linnaeus, first published in 1735; a work which exercised a very powerful influence. Botanists assiduously sought new genera and species. They came to be esteemed within their own circle in proportion to the number of flowering plants the characters of which they knew by heart.

This static eighteenth-century botany, by stimulating the search for new species, brought about its own eclipse. Botanists travelled in the ships of Cook and Flinders and in the nineteenth-century voyages of scientific exploration. Knowledge of the living world grew rapidly and excited great interest. Geology developed the concepts of palæontology, making possible the study of fossil plants initiated by Robert Brown (1851). The concept of species as immutable units each dating back to an act of special creation became suspect. The similarities between species, particularly the basic similarity of structure among the warm-blooded animals, suggested a common ancestry. Fossil organisms were clearly related to, but quite distinct from, living species. Domestic animals and cultivated plants were known to have arisen by human selection of the progeny of their wild ancestors. In the writings of Buffon, Erasmus Darwin and Lamarck, species were regarded as undergoing continuous change, the bewildering variety of living organisms as having arisen from a smaller number of ancestral types and as now undergoing change into the organisms of the future. The situation awaited the synthesis achieved by A. R. Wallace and by Charles Darwin, whose "Origin of Species by Means of Natural Selection" was published in 1859.

Darwin had set forth the immense weight of evidence for the hypothesis that the diverse forms of life are of common descent. Strongly influenced by Malthus, he explained the process of change by postulating that natural variations were inherited and selected in a "struggle for existence". Darwinism and the evolutionary contention of Spencer that the direction of change had been such as to produce higher from lower forms of life became synonymous in men's minds and found wide acceptance and able protagonists.

This concept of organic evolution played an important part in the ferment of scientific ideas which characterized the second half of the nineteenth century. The challenge of Darwinism was, however, not fully understood by contemporary biologists. The systematists saw in it a justification for their work; they embroidered and extended the systems of classification, which now seemed to reveal the evolutionary sequences of the past; there arose a veritable forest of geneological trees. The spirit of the Darwinian period from 1860 until 1900 directed attention away from a really critical examination of the nature and extent of natural variation, and of the mechanism of evolutionary change.

The Study of Cells and of Heredity

To understand how the scientific study of plants was to move forward, it is necessary to go back to the publication in 1665 of the "Micrographia" of Robert Hooke, to his "new invisible world" of the minute structure of plants revealed by the microscope, to the discovery of "cells". This was quickly followed by the work of other seventeenth-century microscopists like Malpighi and Grew, who showed that the stems, roots, leaves and flowers of plants are compounded of many different kinds of cells arranged in patterns of tissues. Further progress, however, had to await the development during the nineteenth century of more powerful microscopes. 1831 saw Robert Brown's description of the nucleus, and 1838 Schleiden's description of the cell substance (cytoplasm) in which the nucleus was always embedded. These together constitute protoplasm, the living substance of the cell. The enclosing cell wall which alone had been observed by the seventeenth-century microscopists was not the cell as we now visualize it, but simply the envelope of structural material secreted around it by protoplasmic activity.

By 1878 Abbe microscopes, with achromatic lenses, were being manufactured and distributed by Zeiss of Jena; they foreshadowed in all essentials the microscopes of to-day. By 1843 certain one-celled plants had been observed undergoing fission into two daughter cells. In 1875 Eduard Strasburger, using an improved microscope and basic aniline dyes as nuclear stains, was able to give the first detailed description of this process of cell division, showing it to be a process led and controlled by division of the nucleus. Preparatory to nuclear division, there appeared in the nucleus minute, deeply staining (chromatin-rich) threads, the chromosomes, constant in number and form in the nuclei of each plant species. During nuclear division these chromosomes underwent a precise longitudinal division so that each daughter nucleus received its proper chromosome complement; the formation of daughter nuclei was followed by division of the cell. Evidence accumulated that the chromosomes were permanent structures the staining properties of which varied with the state of the nucleus.

The new microscopes also made possible study of the process of sexual reproduction at the cellular level. In 1855 Pringsheim introduced his observations thus: "with regard to the manner in which the (sexual) organs participate *materially* in the act of impregnation and even as regards the necessity for their co-operation, there are but vague surmises". Then he proceeded to describe accurately the act of fertilization in the alga *Vaucheria*, thereby demonstrating for the first time that the subsequent development of the female cell into a new plant was not initiated by some mysterious male essence—the "*aura seminalis*" of Aristotle—but by a fusion of the sex cells. This was followed, in 1887, by Beneden's demonstration that in *Ascaris* the essential feature of fertilization is a fusion of the sex nuclei, each with the haploid chromosome number, to give a fusion nucleus containing one set of chromosomes of paternal and one of maternal origin. Preparatory to the formation of sex cells the haploid number was restored by a special reduction division, first observed in plants, again by Strasburger (1894). In this, corresponding chromosomes paired off and then separated to give haploid nuclei each containing some paternal and some maternal chromosomes. These researches pointed to the chromosomes as the physical agents of heredity. Full recognition of their significance came, however, only after botanists and zoologists, labouring to interpret the results of controlled breeding experiments, had formulated hypothetical concepts which described, at first unwittingly, and then with increasing consciousness, the nature and

behaviour of the chromosomes; they had established the science of cytogenetics.

The breeding experiments of Mendel were begun in 1857, published in 1865, and then completely neglected until confirmed and acknowledged in 1900. First Mendel had studied the inheritance of single recognizable characters, for example, average height, when 'dwarf' and 'tall' varieties of peas were crossed and the hybrids selfed. To explain his results, he had to postulate that the expression of the character was controlled by a pair of determinants (in 1909 termed 'genes' by Johannsen), one derived from each parent, that in the zygote the expression of one of these factors was dominant over the other (the 'tall' gene was dominant), and that the maternal and paternal members of the gene pair suffered random distribution to the sex cells formed in preparation for the next generation. Mendel had then extended his work to study simultaneously the inheritance of two characters and concluded that the genes for separate characters were inherited quite independently.

Subsequent work, particularly with the fruit-fly, *Drosophila*, initiated in 1909 by Morgan in Columbia University, extended and modified Mendel's findings. Characters were not inherited independently but in 'linkage groups'; only characters from different groups behaved in a typical Mendelian manner. The number of linkage groups corresponded with the haploid number of chromosomes. Linkage of genes was, however, not absolute; if the genes of the linkage group were on the same chromosome, then there occurred an interchange or 'crossing-over' of genes between paired chromosomes during the reduction division—this was the genetic significance of the 'chiasmata' observed in reduction division. 'Crossing-over' frequencies between genes could only be explained by postulating that the genes are arranged in a linear series along the chromosomes; just as are the chromatin granules of the chromosome threads. The visible structural units of the chromosomes were either genes or were the loci of genes, themselves still smaller material entities. Thus arose the 'theory of the gene', from which has stemmed a deeper understanding of the twin problems of the variability within species and of their change into new species during evolution.

Darwin had postulated that evolution was a process of gradual change, the cumulative effect of successive small variations over many generations. Hugo de Vries, like others before him, was, however, convinced that series of individuals grading from one species into another, such as would be expected from Darwin's hypothesis, are in Nature conspicuous by their absence. In 1886, examining a colony of the American evening primrose, he found variants which on selfing gave rise to quite new and true-breeding forms. Here it seemed was a species disintegrating, suddenly not gradually, to use de Vries's term, by 'mutation'. Similarly, Johannsen (1913), although quite unable to alter gradually the mean seed-weight of beans by always selecting and replanting the heaviest or the lightest seed, encountered two cases of mutation in which the mean seed-weights suddenly changed to new and persistent values. These mutations were apparently quite unrelated in direction or extent to environmental influences. Their discovery, combined with the recognition that heredity operates through special sex cells set aside early in development, formed the starting point for the now generally accepted view that evolution has proceeded by naturally occurring mutation. These sudden changes are quite unrelated to characters 'acquired' during the development of the organism. They are subjected to natural selection or rejection, and, since many are unfavourable, there is a preponderance of rejection.

The rapid accumulation of genetic data which followed the rediscovery of Mendel's work not only exposed the phenomena of 'linkage' and 'crossing-over', but also that of gene interaction. Gene interaction, together with the independent inheritance of 'linkage groups' and their fragmentation by 'crossing-over', showed that inherited variation could arise by a reshuffling, during reduction division, of a fixed gene population. Mutations, the changes important in evolution, were, by contrast, shown to involve either quantitative or qualitative change in the gene population. One kind of mutation arose from breakdowns in chromosome behaviour; their frequency could be speeded up by agents like colchicine and mustard gas. Such chromosome mutations involved deletions or duplications of chromosomes or of chromosome segments; sometimes duplications of whole sets of chromosomes (polyploidy). The second kind, gene mutations, involved radical changes in individual genes. These also occurred naturally with a very low frequency; many mutations of this kind have been induced by X-rays, gamma-rays and other radiations.

It thus became possible to explain at the chromosome-level the concept of species, the nature of natural variation within species and the mechanism of evolutionary change.

Plant Physiology and Biochemistry

It is necessary now to consider the development of a further, and again quite different, level of approach to biological problems.

The seventeenth-century microscopists, observing the development in organic fluids of innumerable moving microscopic organisms, concluded that they had demonstrated the 'spontaneous generation' of life as postulated by Aristotle. Pasteur and Tyndall showed that, in all cases of this kind, the organisms had reached the suitable source of food and moisture by being carried via the air. Their researches also proved that natural fermentations were always associated with living organisms and were not chemical processes in the sense visualized by Liebig. The foundations were laid for the demonstration that infectious diseases were caused by micro-organisms capable of surviving a period of separation from their stricken hosts. Infective fluids could be sterilized either by heat or by removal of the micro-organisms by passage through bacteria-proof filters.

However, in 1892 and again in 1896, it was shown that the juice of tobacco plants infected with 'mosaic' could not be freed from its infectivity by filtration. This observation was a landmark in the discovery of viruses. Further, the infective agent causing the 'mosaic' disease, the tobacco mosaic virus, when isolated by chemical procedures, consisted entirely of ribonucleoprotein. Here was a chemical entity capable of causing an infectious plant disease, requiring suitable living host cells for its duplication, something non-living when isolated, living when introduced into the cytoplasm of the host, in some of its properties an organism, in others a large molecule.

Here we have raised in an acute form the transition from a chemical to a biological level of organization.

In studying life as a material system, as a unique state of matter, we attempt to utilize the techniques of experimental science, particularly those of chemistry and physics, and to extend the concepts of the physical sciences to aid in the interpretation of a higher level of organization. Such studies have revealed life as a dynamic system, a system of happenings, of physical and chemical processes proceeding—have established the science of physiology.

While eighteenth-century botany was preoccupied with systematics, physiology was mainly a speculative occupation of physicians. Outstanding, however, was Stephan Hales, who, working in his vicarage garden at Teddington, sought by experiments to explain the action of living plants on the basis of known physical forces. In 1727 he published "Vegetable Staticks", the foundation work of plant physiology.

By the second half of the eighteenth century, men of many persuasions were studying the nature of air and the effects of plant and animal life on its composition. Priestley, Ingen-Housz and de Saussure were conducting experiments which in aggregate demonstrated that at all times plants and animals are absorbing oxygen and exhaling carbon dioxide (performing respiration); and that in addition green plants have the unique power, in sunlight, to effect photosynthesis. Photosynthesis involved the uptake of carbon dioxide, the evolution of oxygen and the synthesis of organic matter.

These and many other pioneer researches in plant physiology were set forth with great clarity in 1865 by Julius Sachs in his "Physiology of Plants". Here we find respiration described as the process which effects a continuous liberation of energy by the oxidation of the organic food reserves of the cell and the concept that this constant energy supply is essential for the maintenance and growth of protoplasm. Here, in an account illuminated by his own researches, Sachs sets out the general nature of photosynthesis, identifies chlorophyll as the essential catalyst, describes starch as the first visible product and recognizes this as a complex compound capable of yielding respiratory energy or acting as the starting point for the synthesis of other protoplasmic constituents.

The forceful writings of Liebig, particularly the publication in 1840 of his "Chemistry in its Application to Agriculture and Physiology", had led to a wide acceptance of the inorganic theory of plant nutrition, that the essential nutrients required by plants are obtained either from the soil or from the air in inorganic form. Liebig had shown ammonium salts to act as effective sources of nitrogen for plant growth. Boussingault in 1838 had similarly demonstrated the manurial properties of Chilean nitrate, first introduced into Europe in 1820. Boussingault's use of washed sand as a growth medium and the development of water-culture techniques by Sachs and Knop made it possible to identify the elements essential for plant growth, work which ultimately led to the recognition and effective treatment of the important deficiency diseases of crops.

The plant physiologist is, however, not only concerned to define what nutrients are essential but also seeks to trace the chemical changes which they undergo in the chemical reactions of the cell; to trace their role in metabolism. At first, studies of this kind were approached by indirect means, and knowledge of cellular mechanisms was purely circumstantial. However, in 1897, Buchner performed an experiment initiating the science of biochemistry. He obtained from disintegrated yeast cells a clear aqueous solution capable of effecting the alcoholic fermentation of sugar. The biological and chemical theories of fermentation so keenly argued by Pasteur and Liebig had both been vindicated.

The yeast juice of Buchner was afterwards shown to contain a mixture of soluble ferments or enzymes, each responsible for catalysing one of the sequence of linked reactions involved in sugar fermentation. With the progress of biochemical studies it became apparent that enzymes are extremely active, specific and relatively unstable catalysts, and that all, or almost all, the chemical reactions of cells are under enzyme control. When these enzymes were separated and purified, they were found to be either proteins or proteins associated with units of smaller molecular weight, the co-enzymes (some of the latter are now known to be identical with the vitamins). Protoplasm clearly contained several kinds of proteins, reserve proteins, structural proteins responsible for its molecular framework and colloidal properties, and, in small amounts, several hundred specific enzyme proteins controlling cell metabolism.

The discovery of a further kind of protein and a brief discussion of its special role in living cells will serve to illustrate one important way in which plant physiology has deepened our understanding of the major botanical problems the development of which we have followed. Miescher in 1868 isolated the nuclei from pus cells and demonstrated that they contained an unusual phosphorus compound, a new kind of protein, a nucleoprotein. This we now describe as deoxyribonucleoprotein, a compound formed by combination between basic proteins and deoxyribonucleic acid (DNA).

Using modern techniques, it has been possible to study quantitatively the distribution of nucleic acids within cells and to show the universal presence not only of DNA, but also of a second kind of nucleic acid, ribonucleic acid (RNA), also associated with basic protein. From such studies we know that DNA-protein is concentrated in the chromosomes, coinciding in distribution with the chromatin of the cytologists. Nuclei also contain RNA-protein, concentrated in separate nuclear regions and apparently implemented in the synthesis of the DNA-protein.

Nucleic acids were at first considered to be strictly nuclear constituents. The cytoplasm has now been shown to contain cytoplasmic particles, reproducing by fission, rich in RNA-protein, and uniquely rich in enzymes.

Cytoplasm cannot persist in the absence of the nucleus, nor are isolated nuclei self-perpetuating. The two are interdependent. This suggests that the nucleus is dependent upon cytoplasm for organic and inorganic nutrients, and that the nucleus controls cytoplasmic activity by sending out into it 'messengers', some of which it seems from recent genetical work are involved in the origin of persistent and self-duplicating plasmagenes. Viruses may represent plasmagenes which have gained access to and proved capable of multiplying in a foreign cytoplasm and thereby caused a pathological disturbance of metabolism inducing disease symptoms.

The chromatin granules of the chromosomes, carriers of the nuclear genes, cytoplasmic particles, apparently carriers of plasmagenes and other less stable 'gene products', and the viruses are all units capable of self-duplication with retention of their specific properties. They are all nucleoproteins or

are rich in nucleoprotein. Nuclear genes and viruses show mutation. Nucleoproteins confer upon these genetic units their specific properties; nucleoprotein molecules in the environment of the living cell can exactly replicate themselves. We are led to conclude that the massive molecules of nucleoprotein can exist in, at least, as many specific configurations as there are genetic units, that mutations arise from sudden and stabilized changes in their molecular configuration, and that evolution depends upon the structural variations achieved in these special molecules.

The evidence that the RNA-proteins of the nucleus are concerned with the synthesis of chromosome proteins suggests that the RNA-proteins of the cytoplasmic particles may be responsible for the synthesis of enzymes; that genes may control metabolism by controlling, through the medium of their 'messengers', the establishment and activity, in the cytoplasm, of the nucleoprotein centres of enzyme synthesis. Many mutations would then be expected to result in derangements of the delicately adjusted and interlocked reaction chains of cell metabolism. This is the thesis behind the studies in biochemical genetics initiated in 1940 by Beadle and Tatum at Stanford University and afterwards developed in many laboratories. Mutants of fungi and bacteria induced by X-rays have been isolated which have more elaborate and definable nutritive requirements than the parent 'wild' strains. Using appropriate X-ray dosages, many of the mutants have an induced requirement for a single essential metabolite. The induced requirement arises from the breakdown of a single identifiable reaction in cell metabolism. In a number of cases the enzyme controlling the critical step is known and the mutant has been shown to differ from the 'wild' strain in lacking the operative enzyme. Where the micro-organism reproduces sexually, breeding experiments have revealed that the mutants lacking a single enzyme are single-gene mutations. The nuclear genes act, in such cases, by controlling the synthesis of single enzymes. Such gene control could be responsible for the physiological and morphological characters which are the concern of the plant-breeder.

Study of the physiology and biochemistry of nucleoproteins has therefore contributed to our knowledge of the chemical nature of genes and of their mechanism of action, and thereby deepened our understanding of heredity and natural variation.

Contemporary botany has made great contributions not only to the material welfare of mankind, but also to our understanding of life. It is now raising questions enlivening and taxing not only the biological but also the physical sciences. It is in the borderlands between these sciences that, in the immediate future, we may expect the most important discoveries. This poses important problems in the training of biologists and in the development of research.

IS THE GENE A PRIME MOVER?

By Prof. CARL C. LINDEGREN

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RECENT advances in understanding the chemical structure of deoxyribonucleic acid[1] together with evidence[2] of its capacity to mediate the transfer of genes from cell to cell has led to the belief that the secret of life lies in this nucleic acid. Such optimism has its basis in the idea that the gene is the fundamental, 'self-perpetuating', *primary*, living particle[3].

The possibility that the gene is a terminal or recent addition to the cell has not been sufficiently considered. There can be no question that the chromosomes and their genes are essential components of living matter as we know it to-day; but this does not prove that they are *primary* components of living material. Electrical devices are essential components of the organism which we call Chicago, and there is little doubt that, without electrical devices, Chicago would perish and yield its place to some competing metropolis not similarly handicapped. It is equally clear that such devices are not primary components and that Chicago existed as an organism for a long time without them, although they now play a vital part in the city's life.

Numerous critical experiments have shown that extra-chromosomal autonomous structures are present in the cell. (1) Michaelis[4] proved (by back-crossing interspecific hybrids of *Epilobia* to the male parent) that replacing all the chromosomes of one species by those of another did not completely convert the recipient species. (2) Renner[5] has shown that the chloroplasts (which are free of deoxyribonucleic acid) are autonomous structures. (3) Harder[6] showed that the removal of one nucleus from a dikaryon of a hymenomycete (which contains the cytoplasm from both gametes) produces a surviving cell (with nucleus *A* in a mixture of both *A* and *B* cytoplasms) that is permanently different from the parent containing nucleus *A* in *A* cytoplasm—thus establishing the autonomy of *B* cytoplasm.

Now that the gene is allegedly a pure chemical compound, it seems difficult, if not impossible, to ascribe the mysterious capacity for 'self-reproduction' to it. It seems obvious that no chemical possesses an autonomous capacity for reproducing itself, for it must depend upon the environment for its components and the synthesis must be mediated by an enzyme. Self-duplication reduces to a mechanism whereby the enzymes controlling the synthesis and the structure which is synthesized are intimately associated. Many components of the cell other than the chromosomes appear to possess an autonomy which operates at this level. It is as inconceivable that a cell could survive without a plasma membrane as that it could survive without genes. The secret of life is not to be found in the structure of any given chemical, but in the organization and association which make the whole cell capable of producing all the components necessary to the synthesis of all the cellular organelles when placed in an adequate milieu[7]. This statement does not solve the secret; but it denies that the solution lies in the gene alone. Life may have originated by the association of a

synthesizing enzyme with a protein in some circumstances (depending upon structural interrelationships) by which the protein and the enzyme were reconstituted together. The next step could be the development of a differentiated envelope for the protein mass associated with its own synthesizing enzyme. Many synergistic components may have followed, each of which facilitated the synthesis of the complex, and each of which halted all syntheses when the particular components necessary for its construction were in short supply.

The demonstration of the essential nature of the gene depends upon the fact that deletion of a gene produces a lethal result. It is clear from the previous discussion that this fact does not prove that the gene is a primary component of the cell. Actually, one would expect co-ordinating and regulating functions to be superimposed late in the evolution of the cell. Many synthetic steps might involve minute amounts of regulatory materials which were required to act upon a specific substrate for a specific purpose. The critical value of the gene may depend on such a device. The control of adaptive enzymes by genes suggests that such trivial but occasionally valuable activities are controlled by genes. During the early phases of the development of gene theory it was proposed that genes differentiated specific or varietal characters while cytoplasm differentiated characteristics distinguishing genera or phyla. One ordinarily thinks of controlling, supervising and co-ordinating functions as relatively recent rather than primary activities of organizations whether they be cities or countries or cultures; genes may be recent agents in the origin of life carrying on functions similar to those of the electrical devices in a city such as Chicago.

There is a specific characteristic which is not consistent with the view that genes are composed of deoxyribonucleic acid. Evidence[9] concerning the gene controlling galactose-fermentation in *Saccharomyces* has been interpreted to indicate that genes may be plastic, since the substrate for a gene controlling the production of an adaptive enzyme is itself a mutagen controlling the mutation of the gene from a non-functional to a functional state. Similar instances have been encountered in studying the genes controlling carbohydrate fermentation in *Saccharomyces*. Rather than a rigid structure such as deoxyribonucleic acid, the genes themselves may be plastic materials attached to deoxyribonucleic acid. Lindegren[9] suggested that the rigidity of the chromosome made it an ideal site for assembly-line synthesis of gene-products, and the brilliant researches of Demerec (personal communication) have revealed that such assembly-line syntheses actually do occur. There is evidence[10] that gene products may not always be synthesized at the locus of the gene, and this suggestion leads one to suppose that the fibrous nature of the chromosome is exploited as a means of communication and co-ordination, and that the basic functions of deoxyribonucleic acid are to hold the plastic material of the gene in place and to transmit information from it to a functioning cell centre.

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[1] Watson, J. D., and Crick, F. H. C., *Nature*, **171**, 964 (1953).
[2] Hotchkiss, R. D., Symposium on Genetic Recombination, The Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn. (1954).
[3] Muller, H. J., *Science*, **121**, 1 (1955).
[4] Michaelis, P., "Adv. in Genetics", **2**, 1 (1948).
[5] Renner, O., *Ber. d. Math-Phys. Kl. d. Sachs. Akad. d. Wiss.*, **86**, 241 (1934).
[6] Harder, R. A., *Z. Bot.*, **19**, 337 (1927).
[7] Lindegren, C. C., *Symp. Soc. Exp. Biol.*, **6**, 277 (1952).
[8] Lindegren, C. C., and Pittman, D., *J. Gen. Microbiol.*, **9**, 494 (1953).
[9] Lindegren, C. C., "The Yeast Cell: Its Genetics and Cytology" (Educational Publishers, Inc., St. Louis, Mo., 1949).
[10] Lindegren, C. C., *Experientia*, **9**, 75 (1953).

OBITUARIES

Sir Arthur Tansley, F.R.S.

Sir Arthur Tansley, who died on November 25, must be ranked as one of the makers of British botany. During his long and active life he exerted a profound influence on the development of the science and on the attitude of botanists towards the study of the plant world.

Tansley was born in 1871, educated at Highgate School, University College London, and Trinity College, Cambridge. At University College he came under that inspiring personality F. W. Oliver, and at Cambridge he was influenced by Francis Darwin, Seward, and F. F. Blackman, who for many years was one of his closest friends. After taking a first class in Part II of the Natural Sciences Tripos at Cambridge, he returned to London as Quain Student at University College, later becoming demonstrator and assistant professor there. At this period he was much interested in evolutionary problems, then so much in the minds of botanists; he worked on the anatomy of ferns and on seedling structure. In 1902 he embarked on the bold venture of founding a new botanical periodical, *The New Phytologist*, which was to be "a medium of easy communication between British Botanists". He realized that this was a hazardous experiment, and at first he acted both as editor and publisher. The experiment proved completely successful, and in the thirty years during which he was editor the journal became one of the principal botanical publications in the world. It frequently contained important contributions by the editor, such as his "Lectures on the Evolution of the Filicinean Vascular System". It was important, too, in promoting an integration of the various branches of botany hitherto regarded as distinct.

In 1903 he married Edith Chick, his successor in the Quain studentship, and three years later he returned to Cambridge as University lecturer. He settled in a beautiful home at Grantchester which became a centre for botanists young and old. His lectures presented fresh points of view, especially those on ecology, at that time a new subject in Britain. Tansley had begun this study in London with Oliver, and he became an active member of the Committee for the Study of British Vegetation. The work of

this Committee, and the articles in *The New Phytologist* on "Vegetation at Home and Abroad", did much to spread an interest in plant ecology which brought together taxonomists, physiologists and anatomists. In 1911 he organized the first International Phytogeographical Excursion to the British Isles. For this he produced a noteworthy book, "Types of British Vegetation". Two years later he took a leading part in the formation of the British Ecological Society, of which he was the first president; during 1916–37 he edited the Society's *Journal of Ecology*.

During the First World War Tansley undertook work in the Ministry of Munitions, and afterwards he spent a period in Vienna with Prof. Freud. This resulted in his well-known book "The New Psychology", which spread a knowledge of Freud's theories widely in Britain. Afterwards his mind became much occupied with the teaching of botany in schools, and in 1922 he produced an admirable text-book, "Elements of Plant Biology", which had a far-reaching influence. In 1923 he was president of Section K (Botany) of the British Association, and delivered a very stimulating address on the position of botany at that time, in which he called for a new outlook in the study of plants. In the same year he resigned his university post at Cambridge and for a few years occupied himself with research and writing. His important work with T. F. Chipp on "Aims and Methods in the Study of Vegetation", and his "Practical Plant Ecology" date from this period.

A new phase in his career came in 1927 with his election as Sherardian professor of botany and fellow of Magdalen College at Oxford. Here he did much to stimulate and reorganize the study of botany. He collected around him a group of able young men and restored the old prestige of the department. He did much to prepare the way for the provision of a new building, though this was not constructed until after the Second World War.

On his retirement from Oxford in 1937 he devoted himself mainly to the completion of his monumental work, "The British Islands and their Vegetation", in which his own wide knowledge and the labours of British ecologists over some thirty years were epitomized. This fine volume, written in the lucid style which characterized all his works, will long remain as a memorial to his influence and enthusiasm; and it gained for him the Gold Medal of the Linnean Society of London. But his energies were still by no means exhausted, and in 1943 he became chairman of a committee to consider nature conservation and nature reserves in post-war Britain. His book, "Our Heritage of Wild Nature", and his addresses on various occasions did much to arouse a consciousness of the value to the nation of the preservation of areas inhabited by interesting plants and animals. He took an active part in the plan for helping teachers and students of all kinds to study plants and animals in their natural habitats, becoming president of the Council for the Promotion of Field Studies; he also provided students with "An Introduction to Plant Ecology", and was joint author of "Plant Ecology and the School". His appointment as first chairman of the Nature Conservancy in 1949 was a fitting climax to his efforts for so many years.

Tansley's work was recognized by his election to the Royal Society in 1915, to an honorary fellowship at Trinity College, Cambridge, in 1944, and by the conferment of a knighthood in 1950.

He will be widely mourned as a leader and a friend.

H. Hamshaw Thomas

Sir Richard Paget, Bart.

Sir Richard Arthur Surtees Paget died on October 23 at the age of eighty-six. He was educated at Eton and Magdalen College, Oxford. After qualifying as a barrister and becoming a member of the Inner Temple, he gave valuable services on a number of industrial panels and commissions, where his genial personal qualities fitted him well as a negotiator. The bulk of his life, however, was spent in the cause of science. He loved science and brought the scientific attitude of mind to bear upon problems in many diverse fields—thus he achieved important work and gained distinction in physics, anthropology, architecture, town planning, acoustics, linguistics, speech and several artistic crafts. He was, moreover, of an inventive turn of mind, delighting in novel and unorthodox ways of viewing things, so that it is not surprising that he anticipated by half a century some present-day developments such as the streamline motor-car.

When in 1915 Britain was faced with calamity, he was one of the first to realize the urgency of well-directed scientific research on a national scale; he acted as assistant secretary of Section II of the Admiralty Board of Invention and Research during 1915–18. Not a few of the practical investigations undertaken by the Board during the First World War were the direct result of his foresight, to which tribute was paid on more than one occasion by the late Sir William Bragg, who was in charge of experimental work for the Navy.

Mention must be made of Sir Richard's keen interest in the arts. He was an accomplished musician, being particularly adept at keyboard improvization and composition. Folk music had a great fascination for him and provided an interest which he was ultimately able to link with his later studies on speech and language. Coupled with his inventiveness was a rare manual dexterity leading to skill in scientific experimentation and many forms of practical art; for example, he excelled in the manufacture of pottery. As recently as June 1954, prior to a Friday Evening Discourse at the Royal Institution, he created intense interest by demonstrating his early models of the action of the vocal apparatus by which he could reproduce consonants and vowels, thereby simulating human speech. Though these models were connected with work done more than forty years ago, they struck the observer most forcibly at once by the elegance of their simplicity and their appropriateness for the purpose in hand. It is good to know that Sir Lawrence Bragg has now received the models for the Royal Institution Museum and will use them in his lectures from time to time.

Perhaps the most outstanding work of Sir Richard Paget was that upon speech and language. His extreme humanitarianism led him to exert himself to the full in the cause of the deaf and dumb. He put much effort into the development of a sign language for their use.

Several glowing appreciations of Sir Richard's scientific work have already appeared in the Press, both at home and overseas. All of them stress his amazing versatility, his originality of outlook, his zest for life and, above all, his great personal charm and humanity. Perhaps, in concluding, I may be permitted to introduce a personal note. When in 1938 I was faced with the task of opening the large new South-West Essex Technical College and School of Art, the extremely diverse problems involved in

equipping departments of science, engineering, architecture and building, commerce, women's subjects, and not least a school of art, were just such as to appeal to Sir Richard's 'universal' mind. He gave me much practical advice and designed not a few special pieces of equipment for me. He afterwards addressed the students with great success. The building of the College organ also interested him, and at the opening recital he sketched the instrument and the organist. There must be many like myself who cherish memories of his ready, generous and expert counsel and assistance. H. LOWERY

NEWS and VIEWS

Dr. Karl Jordan, F.R.S.: Ninety-fourth Birthday Presentation

DR. KARL JORDAN, the distinguished entomologist, was honoured on his ninety-fourth birthday by the presentation of a jubilee volume at a meeting of the Royal Entomological Society held at the Society's house in Queen's Gate, London, on December 7. The volume contains a series of essays and scientific papers by entomologists of many countries reflecting the numerous facets of Dr. Jordan's work. The essays include a biography, and reviews of Jordan's work in organizing the International Congresses of Entomology, his work for the organization of zoological nomenclature, his work on fleas, his influence on current concepts of systematics and evolution, his contributions to the systematics of Anthribid beetles and his work on the Lepidoptera. There follow a bibliography listing some 460 items written by Dr. Jordan over a period of seventy years, and twenty scientific papers. Few men can have contributed more to the science of entomology than Dr. Jordan, and it was fitting, and a sign of the high regard in which he is held throughout the world, that the jubilee volume was initiated in the United States. It was Mr. H. K. Clench, of the Carnegie Museum, Pittsburgh, who fired the enthusiasm of friends of Dr. Jordan in the United States, Canada and in Britain, and who was responsible for a large part of the work of assembling the contributions. The Royal Entomological Society of London, of which Dr. Jordan is an Honorary Fellow, undertook the publication of the volume.

Peaceful Uses of Atomic Energy: India and the United Kingdom

THE United Kingdom Atomic Energy Authority states that discussions between the United Kingdom Atomic Energy Authority and the Indian Department of Atomic Energy have led to the conclusion of an agreement which ensures that there shall be close co-operation and mutual assistance between the Authority and the Department in the promotion and development of the peaceful uses of atomic energy. The agreement provides for the Authority and the Department to arrange for members of their staffs to consult and work together on mutually agreed topics. In furtherance of this agreement, the United Kingdom Atomic Energy Authority will provide the Indian Department of Atomic Energy with enriched uranium fuel elements for a 'swimming pool' reactor now under construction at Bombay. The agreement also includes arrangements for the Authority to assist in the design and construction of a high-flux research reactor which may be built at a later date.

Technical Education in Great Britain

REPLYING to questions on technical education in the House of Commons on December 13, the Prime Minister re-affirmed the Government's determination to make a big advance in technical education and said that the Minister of Education would make a further statement shortly on technical colleges. Sir Anthony Eden did not think that appointment of a committee to inquire into all aspects of scientific, technological and technical training or of a Minister for Technical Education would help. He gave no direct reply to questions regarding the position relative to the U.S.S.R., but said that last year about £4·5 million was spent on improvements in various spheres of technical education. This year £7 million is being spent and next year £9 million. No contracts for technical colleges in Britain were placed during 1946–47, but during subsequent years the figures are: 1948–49, £222,000; 1950–51, £874,000; 1952–53, £3,307,000; and last year just under £7 million.

Sea-going Facilities for Naval Scientific Workers

INCREASING facilities are being granted by the Royal Navy so that scientists, designers and others concerned with the development of new equipment for the Navy can serve afloat and study the problems of those who use their equipment. For some time naval officers have been specially appointed to naval research and development establishments in an endeavour to ensure that civilian officers fully appreciate naval problems, but it is being more and more realized that knowledge and appreciation cannot be fully acquired through the experience of others. Long periods at sea are possible only for a small proportion of those in the Royal Naval Scientific Service engaged on research, design and the production of naval equipment, but many, including draughtsmen, do visit ships for trials and inspections, even if they do not always proceed to sea. During fleet exercises a number of civil officers are embarked in various units of the fleets as observers to study the general problems of operation and weapon efficiency, and there are, of course, members of the Royal Naval Scientific Service attached to the staffs of the Commanders-in-Chief, Home Fleet and Mediterranean Fleet, as fleet scientific advisers. During recent years the amount and complexity of electronic equipment now fitted in ships have increased to such an extent that special efforts are made to enable the designers and producers of this equipment to study at sea the problems of the user and the maintenance staff. During the past eighteen months the fleets have been able to accommodate in various ships, for periods varying between a few days and four or five weeks, about one hundred civil scientific officers engaged in this sort of work; included in this number are staff representatives from Ministry of Supply Establishments, which are responsible for most of the airborne electronic equipment for the Navy, and also designers and engineers of industrial firms engaged on Admiralty work.

Vacation Courses in Synoptic Meteorology

For the sixth year in succession, the Royal Meteorological Society, in conjunction with the Council for the Promotion of Field Studies, held in the early autumn a vacation course in elementary synoptic meteorology at the Council's field-centre at Malham Tarn. This year, however, in view of the increasing number of applications, a parallel course for sixth-form pupils was also held at the Juniper Hall Field-Centre. The course at Malham Tarn was attended by thirty-five students, mainly undergraduates, reading for degrees in mathematics, physics and geography, and the Juniper Hall course had an attendance of thirty-two. The instructors at Malham were Mr. C. D. Ovey, lecturer in geography at the University of Cambridge, and Dr. R. S. Scorer, lecturer in meteorology, Imperial College; Mr. E. J. W. Spence dealt with the construction and use of meteorological instruments. At Juniper Hall the instructors were Mr. W. D. S. McCaffery and Mr. C. E. Wallington, both of the Meteorological Office. The visiting lecturers at Malham included Prof. P. R. Crowe, University of Manchester, who discussed "Some Problems of Tropical Weather"; Dr. D. Walker, University of Cambridge, who gave a talk on palæo-ecology; and Prof. G. Manley, Bedford College, London, whose subject was "The Study of Climatic Variations". At Juniper Hall, Mr. R. E. Lacy, Building Research Station, dealt with meteorological problems in the building industry; Mr. H. Charnock, National Institute of Oceanography, explained the inter-relationship between oceanography and meteorology; Mr. R. A. McCormick, at present visiting Great Britain on an exchange basis between the U.S. Weather Bureau and the Meteorological Office, described the work of the former; Mr. D. H. Lucas, Central Electricity Authority Research Laboratories, spoke on smoke pollution; and Dr. R. M. Goody described research on the upper stratosphere. At Juniper Hall an excursion to the Meteorological Office Radiosonde Station at Crawley was arranged, and a visit was also paid to the Research Laboratories of the Central Electricity Authority at Leatherhead. An important part of the course consisted of observation work and the plotting of synoptic meteorological data. A novel feature at the Malham Tarn course was the use of a specially equipped meteorological van, kindly lent by the Department of Meteorology of the Imperial College of Science and Technology. Simultaneous observations of pilot balloons by two theodolites were made by radio-communication. As in previous years, various education authorities and the Education Department of the R.A.F. made it possible for some of the students to attend the courses, which are approved for grants in suitable cases. Similar courses will be held in 1956 at the Malham Tarn Field-Centre for undergraduates during August 22–29 and at Flatford Mill Field-Centre for sixth-form pupils during September 5–12. Early application is advisable.

An Abnormal Smoke Belt over London

About 1 p.m. on Sunday, January 16, 1955, a belt of extreme darkness crossed the London area from north-west to south-east, causing widespread public interest and attention in the press. The belt of smoke and low cloud was about 1½ miles wide and moved at 6–18 m.p.h., taking 6–10 minutes to cross a given place. The daylight illumination as recorded at Kew Observatory (normally about 7 kilolux at this time on overcast days in January) dropped at 1.14 p.m. from 7 kilolux to a value barely distinguishable from zero. In the November issue of the *Meteorological Magazine* (p. 342), N. G. Helliwell and M. J. Blackwell describe the physical causes. The essential features were a low inversion of temperature (increase of temperature with height instead of the usual fall) beneath which smoke was trapped, and a change of wind direction associated with the eastward movement of the centre of a depression across London. The smoke was carried north-westwards, first of all by the south wind ahead of the centre to the Chilterns, and concentrated there against a front with north-easterly winds on its northern side. As the depression moved, the wind changed to north-west and brought the smoke belt back across the London area. Trajectories of the smoke are given in the paper. It was possible from observations to trace its further movement south-east to the Sussex coast. The amount of smoke pollution at the Fuel Research Station, Greenwich, increased from 0·36 mgm. m.$^{-3}$ between 1 and 1.15 p.m. to 0·7 mgm. m.$^{-3}$ during 1.45–2.45 p.m., when the extreme darkness occurred there. At Grosvenor Road the maximum pollution of 1·3 occurred earlier, and the value at the time of darkness was 0·3. During the infamous smoke fog of December 5, 1952, the pollution reached 4·5 mgm. m.$^{-3}$ at Greenwich.

University of London

The following appointments have been made in the University of London: Dr. B. C. King, senior lecturer in the University of Glasgow, to the University chair of geology tenable at Bedford College; and Dr. K. W. Sykes, senior lecturer in the University College of Swansea, to the University chair of physical chemistry tenable at Queen Mary College. The title of reader in biochemistry in the University of London has been conferred on Dr. A. L. Greenbaum in respect of his post at University College.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: D. C. P. Evans (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; J. S. Addison, J. S. Smith and M. L. Webber (conservators of forests, Federation of Malaya), conservators of forests, grade A, Federation of Malaya; A. Foggie (conservator of forests, Gold Coast), deputy chief conservator of forests, Gold Coast; F. G. Harper (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; F. H. Landon (conservator of forests, Federation of Malaya), chief research officer, Federation of Malaya; D. McIntosh (conservator of forests, Northern Region, Nigeria), deputy chief conservator of forests, Northern Region, Nigeria; B. E. Webb (forest engineer, Federation of Malaya), conservator, development and utilization, Federation of Malaya; M. S. Garson (geologist, Nyasaland), geologist, Cyprus; Dr. E. R. N. Cooke (pathologist, Kenya), specialist (pathologist), Kenya; P. B. Cornwall (scientific officer, West African Cocoa Research Institute, Gold Coast), senior scientific officer, West African Cocoa Research Institute, Gold Coast; A. E. Dorman, J. F. Hart and R. W. E. Lewis (veterinary officers, Kenya), provincial veterinary officers, Kenya; K. D. S. MacOwan (deputy director of veterinary services, Kenya), director of

veterinary services, Kenya; K. D. S. Baldwin, economist, Agriculture Department, Northern Region, Nigeria; J. A. Bullock, scientific officer, entomologist, Kenya; J. C. Davies, entomologist, Department of Agriculture, Uganda; F. Isherwood, scientific officer, entomologist, East Africa High Commission; W. P. Mowat, scientific officer, plant pathologist, Sarawak; N. C. Loveday, assistant conservator of forests, Tanganyika; D. R. McQueen, silviculturist, Nyasaland; M. T. Ashcroft, medical research officer, grade 2, East Africa High Commission; M. N. Henry, pathologist, grade B, Trinidad; P. D. Meers, pathologist, Nigeria; A. W. Ireland, deputy director of meteorological services, Nigeria; C. P. MacKenzie, veterinary education officer, Nigeria; S. M. Rimmer, veterinary officer, Tanganyika; D. J. Garrod, scientific officer, East African Fisheries Research Organization, East Africa High Commission; D. J. C. Orr, game ranger, Tanganyika; Dr. E. W. Russell, director, East African Agriculture and Forestry Research Organization, East Africa High Commission; E. A. Salzen, scientific officer, marine biologist, West African Fisheries Research Institute, Sierra Leone; P. D. Turner, mycologist, West African Cocoa Research Institute, Gold Coast.

The Night Sky in January

New moon occurs on Jan. 13d. 03h. 01m., U.T., and full moon on Jan. 27d. 14h. 4m. The following conjunctions with the Moon take place: Jan. 1d. 23h., Jupiter 7° N.; Jan. 8d. 11h., Mars 2° N.; Jan. 8d. 18h., Saturn 4° N.; Jan. 14d. 22h., Mercury 4° S.; Jan. 16d. 09h., Venus 7° S.; Jan. 29d. 06h., Jupiter 6° N. In addition to these conjunctions with the Moon, Mars is in conjunction with Saturn on Jan. 14d. 21h., Mars 1·6° S., and with Antares on Jan. 26d. 21h., Mars 5° N.; also, Jupiter is in conjunction with Regulus on Jan. 27d. 19h., Jupiter 0·7° N. Mercury sets at 17h., 17h. 55m. and 16h. 10m. on January 1, 15 and 31, respectively. Its stellar magnitude varies from −0·7 to 2·1, and the visible portion of its illuminated disk from 0·864 to 0·046 during the month; it will not be so conspicuous towards the end of the month in spite of the fact that it attains a greater altitude. Venus sets at 18h. 25m., 19h. 10m. and 20h. on January 1, 15 and 31, respectively. Its stellar magnitude varies from −3·4 to −3·5 and the visible portion of its illuminated disk from 0·868 to 0·796, its distance from the Earth varying between 129 to 113 million miles. Mars rises shortly after 4h. during January and has an eastward motion through Libra and Scorpius. Its stellar magnitude varies from 1·7 to 1·5, and its distance from the Earth from 195 to 171 million miles. Jupiter rises at 20h. 40m., 19h. 35m. and 18h. 20m. at the beginning, middle and end of the month, respectively, its stellar magnitude varying between −1·9 and −2·0, owing to its distance from the Earth decreasing from 437 to 411 million miles; its westward motion in Leo can be observed by comparing its positions with reference to Regulus during the month. Saturn rises at 4h. 50m., 4h. and 3h. on January 1, 15 and 31, respectively, and has an easterly motion in Scorpius; but it lies rather low for good observation in the British Isles. It is fairly close to β Scorpii during the month, and its stellar magnitude remains 0·8. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Jan. 1d. 02h. 07·4m., ω Leo. *m* (*R*); Jan. 16d. 18h. 32·5m., 51 Aqr. *m* (*D*); Jan. 31d. 06h. 39·0m., 13 *B* Vir. (*R*), *R* and *D* referring to reappearance and disappearance, respectively. The Earth is in perihelion on Jan. 2d. 13h. The Quadrantid meteors are active on the first few days of January, but moonlight will interfere with their observation.

Announcements

Mr. J. P. Doncaster, at present in charge of the collections of aphids and allied groups of insects in the Department of Entomology of the British Museum (Natural History), has been appointed a deputy keeper of the Department.

Dr. R. L. Mitchell, head of the Department of Spectrochemistry, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen, has been appointed deputy director of the Institute, and Dr. E. G. Williams head of the Department of Soil Fertility.

Mr. W. T. O'Dea, keeper of the Department of Aeronautics and Sailing Ships in the Science Museum, London, has been released for three months to undertake an exploratory mission for Unesco as technical assistance expert in Ceylon under the Colombo plan. He will advise the Government of Ceylon on the establishment of a science museum at Colombo and will call at New Delhi on his return journey to discuss with representatives of the Government of India their proposals for science museums in four widely separated localities.

The Scientific Instrument Manufacturers' Association is arranging to hold a permanent exhibition of instruments made by member firms at its headquarters at 20 Queen Anne Street, London, W.1. The exhibition, which will be opened on February 9, is not intended to be public, but it will be open to anyone interested in using scientific instruments.

A David Anderson-Berry Silver-Gilt Medal and a sum of about £100 will be awarded in 1956 by the Royal Society of Edinburgh for work on the therapeutical effect of X-rays on human diseases. Both published and unpublished work may be submitted. Applications and copies of relevant papers must be sent to the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, not later than March 31.

Applications are invited for a Drummond senior fellowship and not more than two Drummond junior fellowships for research in nutrition, both tenable for two years. The senior fellowship will be worth £900 a year with research expenses not exceeding £50, and up to £90 a year for superannuation, and the junior fellowship will be worth £500 a year, with research expenses not exceeding £75 a year. Application forms, to be returned by January 27, and further information can be obtained from the Honorary Secretary, Drummond Trust, University College, Gower Street, London, W.C.1.

The authors of the article entitled "Laboratory Design", published in *Nature* of November 26, p. 999, write: "This investigation was assisted by a grant made by the Agricultural Research Council to the Nuffield Foundation. Acknowledgments also are due to Sir William Ogg, director of the Rothamsted Experimental Station at Harpenden, and to Prof. H. D. Kay, director of the National Institute for Research in Dairying, Shinfield, Reading, and their staffs for giving facilities for the survey described, and to the Trustees and Director of the Nuffield Foundation for permission to publish the work".

ENGLISH STYLE IN SCIENTIFIC PAPERS

SINCE the publication in *Nature* of November 5 of Dr. J. R. Baker's article on the use of English in scientific papers and the accompanying editorial article, we have received a number of letters commenting on the situation. We print below a selection covering the main points raised.

Dr. J. R. Baker asks, "How can the standard of English in scientific journals be improved?" It is true that I have sometimes been conscious of an uncharitable desire to be able to write book reviews in the style of Macaulay, a desire which I should presumably not have experienced if I had not read Macaulay; but I do not believe that any substantial improvement will be brought about, at the level which matters most, by relying on the too comfortable doctrine that 'good reading makes good writing'. If standards are to be raised, those concerned with the education and training of scientists, from the early forms of the grammar schools onward, must believe that the writing of good English is important, and must make the weight of their belief felt by means of appropriate sanctions—by making pupils rewrite slovenly essays, by refusing to approve badly written Ph.D. theses, and so on.

But surely the short answer to Dr. Baker's question is "by the refusal of editors to print bad English". When I started to write scientific papers, most of them were edited by the late Dr. Clarence Smith, to whom I owe a great debt of gratitude for what I was at first inclined to regard as tyrannical restriction; on many occasions he showed me how economy of words and clarity of expression went hand in hand, and even when I could not agree with his alterations, I benefited by being forced to think hard about my writing. I am sure that editors still help young authors in this way; but I believe that the more ruthless use of the editorial pen could do much to raise the standard of English in our scientific journals.

On points of detail may I remark first that, although the principles involved in their correct use may be simple enough, in my experience the best advice to give about gerunds and present participles is to avoid them; thus the phrase "on opening the body-cavity" used by Dr. Baker could easily be incorrect in a slightly different context, so that it is much safer, and on the whole more direct, to write "when the body-cavity is (was) opened". Secondly, much clumsy periphrasis is caused by our avoidance of the first person; could we not agree that clarity is more to be prized than false modesty?

E. G. Cox

School of Chemistry,
University of Leeds.

In his excellent article, Dr. J. R. Baker justly says that understanding is impeded by the misuse of words and by perverse or slovenly syntax. I would like to direct attention to a related problem: the growing inadequacy of the language itself as a means of expression. There are already too few words available to writers and the situation is growing worse.

Since the industrial revolution, the rate of appearance of new things, new activities, and new qualities has been faster than ever before in the world's history. At the same time, universal education, the spread of literacy, and a willing subjection to the tyranny of the dictionary have restricted the introduction of new words.

Sea-going folk are adequately supplied with words; words which were originated by seamen were afterwards authorized by the dictionary-makers. But the language of aviation is sterile. We have a few cumbersome terms: bomber, fighter, airliner, seaplane, monoplane, biplane, and so forth, some of which have courageously been invented to meet an obvious need. But the rate of invention is not high enough. This is especially noticeable when something new appears. The Rolls-Royce jet-lifted vehicle is a good example of this. Clearly this is a member of the class of aerodynes; but it is neither an aeroplane nor a helicopter. What are vehicles of this kind to be called? Need we descend to the facetious and use such terms as 'flying bedstead' to describe a most advanced piece of engineering.

What are we to do about guided missiles? Many different kinds are being developed now, and the only way of describing them seems to be with the aid of abbreviations, SSM, ASM (surface-to-surface missile; air-to-surface missile) and so on. Many of them use rocket propulsion. But what is a rocket? It used to be the complete vehicle, comprising propulsive means, stabilizing means, container and payload; but as the vehicles grow bigger and we approach space-ships, the word is becoming limited to the motor itself.

Since there is, in fact, no shortage of letter combinations (nor of sound combinations) there seems no reason why new words should not be made concurrently with new things. It is in fact true that there have been considerable successes in this way ('radar' is a good example), but we need many more. The main requirements are common sense and courage. There will be many who will resist any attempt to introduce a word that is not already in the dictionary. Such people may be quite prepared to avail themselves of a modern product such as a cathode-ray tube, but they will not have the grace to allow it a word of its own.

D. M. Desoutter

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Dr. J. R. Baker's description of some symptoms of a linguistic disease will have delighted all concerned with problems of information. May I point out two more of its deplorable effects: (*a*) the many Continental authors who now write directly for British or American publication may be led to take it as a model, neglecting the study of the very real virtues of American (not to mention English, which some of us in our old-fashioned way think equal to any task, even if it does not make up into such comfortably broad-bottomed volumes); and (*b*) now that printing is costed almost to the last 'en', one not only has to suffer this pompous verbosity, but also to pay extra for it.

P. J. Edmonds

Cleaver-Hume Press, Ltd.,
Publishing Division,
31 Wright's Lane, London, W.8.

Dr. John R. Baker and the Editors of *Nature* have indicated some of the unhealthy symptoms in contemporary scientific writing and have made constructive suggestions regarding diagnosis and treatment. One fundamental factor which they have still overlooked is the almost universal evasion of the word "I", which evasion, in my opinion, is responsible for much of the circumlocution, artificiality and apparent 'genteelism' and 'grandiloquence' of scientists and bureaucrats alike.

There is one standard objection to the use of the personal pronoun: that it is immodest in a research worker because it imparts a personal flavour when science should be impersonal as well as unbiased. The psychologist McDougall[1] has trenchantly refuted this argument: "There is a common form of egotism which consists in ostentatiously avoiding the appearance of egotism. In conversation one avoids the words 'I' and 'me' as though they were among the most disgraceful in the language; one finds oneself most at ease with persons who do not offend one's susceptibilities with blatant egotism and who can appreciate one's freedom from that gross fault, a fault one cannot tolerate. In writing, and especially in early efforts, one refers not infrequently to 'the present writer' or 'the author of these pages', and uses other ponderous circumlocutions in the effort to avoid the solecism of appearing in the first person".

I doubt very much whether ignorance of basic grammar constitutes a major difficulty for the average scientist of research calibre, or whether he really needs more than the occasional second opinion of a friend or the occasional consultation of "Fowler". It is rather that the scientific author, like the official or the honorary official, somehow feels that everyday language is not quite important enough for his purpose. One junior worker among many who have commenced a paper on the lines: "Working out a collection of animals from Katmandu, three new species were found", listened politely as I asked if he realized that he had perpetrated, not only a grammatical monstrosity but an idea-picture which, taken literally, would need a Lewis Carroll or an Edward Lear to do it justice. Would he speak in that way? Would he describe his work in just those words in a letter to a friend? "Well, no," he answered, "but looking through other people's papers I thought that was how you were supposed to write."

I believe that the kernel of the whole problem lies in the individual's choice of reading. Laymen and scientists alike who have delighted in the lucid and majestic language of one of the greatest living masters of English prose may well ponder Sir Winston Churchill's account[2] of the days when he took his own education in hand and set out to read Gibbon's "Decline and Fall of the Roman Empire" because "Someone had told me that my father . . . knew whole pages of it by heart, and that it had greatly affected his style of speech and writing". Let every young biologist, for example, take Aldous Huxley's essay[3] as guide and soak himself in the writing of T. H. Huxley. Let him read (in translation) the communications of old Antony van Leeuenhoek[4], as fresh now as when they were written more than two hundred years ago, as precise as the most puritanical of pure scientists could desire, as concise as the most frugal editor could demand and, incidentally, bristling with I's and none the worse for them.

There will be those who, once the elementary requirements of accuracy and brevity have been met, will belittle the importance of literary style in scientific writing and will apply the adjective 'literary' out of criticism, pity or simulated contempt. I think they will be profoundly wrong to do so. Until a few decades ago scientists and technicians combined with statesmen, public officials, lawyers, clergymen and popular novelists to form an influential community adequate to maintain the purity of our language. To-day the balance of power has changed for the worse. The age of Newspeak may be even closer than Orwell[5] prophesied.

Denys W. Tucker

British Museum (Natural History),
London, S.W.7.

[1] McDougall, W., "Character and the Conduct of Life" (Methuen, London, 1927).
[2] Churchill, W. S., "My Early Life" (Macmillan, London, 1930).
[3] Huxley, A., "T. H. Huxley as a Literary Man" (Huxley Memorial Lecture: Macmillan, London, 1932. Reprinted in "The Olive Tree" (Chatto and Windus, London, 1936)).
[4] Dobell, C., "Antony van Leeuenhoek and his 'Little Animals'" (John Bale, Sons and Danielsson, London, 1932).
[5] Orwell, G., "Nineteen Eighty-four" (Secker and Warburg, London, 1949).

It is stated in *Nature* of November 5 that "The time does not seem far away when high school pupils will have to learn a new table of symbols apart from those atomic". It would, however, appear that such a sad state already exists, the symbols and abbreviations being too numerous for a mere twenty-six letter alphabet.

Another difficulty is that the pupil has to know several glossaries of symbols, to be in line with different authorities.

David Want
(Sixth-form pupil)

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USE AND ABUSE OF PROTECTIVE EQUIPMENT

The fifth conference of the British Occupational Hygiene Society was held in London on November 4, the theme of the conference being "The Use and Abuse of Protective Equipment". It was divided into four sections dealing with the protection of the lungs, skin, eyes and feet. The proceedings will be published in the March issue of the *British Journal of Industrial Safety*, and reprints will be obtainable from the honorary scientific secretary of the Society, D. Turner, Environmental Hygiene Research Unit, M.R.C. Laboratories, Holly Hill, London, N.W.3.

The morning session was opened by S. H. Wilkes (senior chemical inspector of factories), who warned against using the canister respirator inside tanks, stills or other closed spaces where there may be high concentrations of toxic gases or where shortage of air is possible. Papers on the protection of the lungs were presented by A. C. Peacock, of the Chemical Defence Experimental Establishment, Porton, and by J. Whittaker, of the Central Safety Department, Imperial Chemical Industries, Ltd. After stating that the only fully satisfactory method of protection of the lungs is by suppression of the risk at source, Mr. Peacock described the different respirators available for use when the ideal cannot be realized.

Characteristics necessary in types suitable for continuous wearing have necessitated a compromise in design between degree of protection and acceptability to the wearer. A review of the standard of protection demanded will sometimes result in a very much more wearable device.

Mr. Whittaker emphasized the importance of a good fit of face-pieces, which is easier to secure with full-sized face masks, going under the chin, than with the small kind covering only the mouth and nose. The larger the protective appliance, however, the greater is the aversion to wearing it and the risk of its being surreptitiously discarded. Discipline in the atomic energy field in this respect is better than in older industries because the workers are well aware of the danger and are accustomed to imperceptible risks.

The second section of the conference consisted of papers on the protection of the skin by Prof. J. R. Squire, of the Department of Experimental Pathology, University of Birmingham, and by Dr. A. Lloyd Potter, of the General Chemicals Division, Imperial Chemical Industries, Ltd. Prof. Squire described how the outer layer of the skin is chemically inert but swells in alkalis and, being a protein, can react with or absorb substances containing $-NH_2$ or $-SH$ groups. It can be destroyed by reducing agents and cracked if dried excessively. Loss of water is normally impeded by a surface film of fatty material which is replenished naturally after removal with solvents in about two hours. Mechanical abrasion, leading to wear of the horny surface faster than the germinal layer can replace it, is occasionally encountered in industry. Chemical irritants produce their effect rapidly when they act as sensitizers, in which case an intense reaction may follow a second exposure, even to very small quantities, after an interval of ten to fourteen days. Carcinogens require years to produce even precancerous effects, and the peak incidence of skin cancer is twenty to thirty years after exposure. Repeated exposure is necessary, and the action decreases when less of the carcinogen reaches the skin.

Dr. Lloyd Potter said that in order to affect the skin a substance must wet it, either by being itself liquid or by solution in perspiration or other liquid. Water, alcohol and weak acids do not greatly affect the skin; but alkalis and fat solvents penetrate to the sebaceous layer. Liability to dermatitis is not detectable at pre-employment medical examinations. Protection of a process by complete enclosure may be nullified if the final product is packed by hand. Protective clothing should not add to the risk of contracting dermatitis by causing sweating and chafing. Proper washing facilities should be provided for and used by workers, and, in this connexion, barrier creams are good because they encourage washing.

Speakers in the afternoon session were introduced by Sir Harold Roberts (chief inspector of mines), who stated that mining is the most dangerous of industries, being closely followed by shipping in respect of fatalities. The death-rate in coal mining is nine times as high as the death-rate in factories, major catastrophies being responsible for only a very small proportion of the casualties in mines; the major toll is taken by falls of ground and by transport operations. Owing to improved standards of lighting, the incidence of nystagmus has been greatly reduced.

Dr. D. R. Campbell, director of research, Birmingham and Midland Eye Hospital, in a paper on ocular injuries and hazards, said that eye injuries constitute 4·26 per cent of all industrial accidents and are mostly preventable, being due to flying particles. Goggles are liable to steam up; they restrict vision and are uncomfortable to wear. They are better received if the worker is given a number of kinds to choose from. Ocular injuries are often repairable, now that the complication of infection is largely absent, but even a small scar on the centre of the cornea can cause dazzle in artificial light. Eye protection, she said, should be compulsory when striking and chipping with metal tools. Burns from molten metals and chemicals, especially caustic soda, are dangerous, though immediate irrigation with water may save an eye.

The legal obligation to provide eye protection against certain hazards was then explained by G. V. Thom, safety officer, Plastics Division, Imperial Chemical Industries, Ltd. Protection built in to a machine is more desirable than protecting the operator, and he showed typical examples. Various devices for personal eye protection were described. In the particular case of welding, protection against infra-red rays is needed, and against ultra-violet as well in electric-arc welding.

H. Bradley, director of the British Boot and Shoe and Allied Trades Research Association, was the first speaker in the session on the protection of the feet, and outlined the steps which have led to the drafting of British Standards for safety footwear. These contain a steel toe-cap which has to resist an impact test. He was followed by H. E. Thomas, head of the Safety Department of the Ford Motor Company, who said that, in his experience, the standard safety boot did, in some cases, give protection but that many toe fractures while wearing them continue to arise. He thought these could be avoided by extending the toe-cap backwards. It is true that it would then be unable to pass the impact test, but it is evident that considerable deflexion of the toe-cap is possible without injury to the wearer's foot.

C. N. Davies

THE FUNCTION OF LIBRARIES

At the annual conference of the Library Association, held in Southport during September 20–23, two speakers concerned themselves particularly with the university library. Sir Philip Morris, in his presidential address on September 20, drew on his experience in visits to universities overseas since the Second World War, when he found that there was no university which was not either replanning or developing its library, designing a new library and library service, or had just completed some new library undertaking. In Canada and the United States last year he saw, and discussed with those responsible for, five large new libraries completed within the past two or three years. All were different, and while there appeared to be no single answer to the problem of library design, the physical environment, arrangement and facilities of a library profoundly affected its service, and there appeared to be a growing need for much more co-operation and interdependence between libraries. Sir Philip believes that the efficiency of a university might be said to be a function of the adequacy and efficiency of its libraries, and, apart from this factor of co-operation, he emphasized the importance of books being avail-

able in suitable circumstances for the reader, and especially the importance of high standards of education and professional ability on the part of the library staff.

These points were elaborated more fully later at the conference by Dr. L. W. Sharp in a paper entitled "What do we look for in a University Library?" Dr. Sharp said little of library co-operation, believing it to be in a very healthy state so far as university libraries are concerned. He referred, however, to some of the difficulties occasioned by departmental libraries and made some suggestions for co-operation here in regard to book selection, exhibits and the like. Like Sir Philip Morris, he stressed the supreme importance of the quality of the library staff, referring to the importance of a university librarian having other academic interests and of encouraging his assistants to widen their interests, for example, through exchanges of staff with other libraries at home and abroad and by the provision of more research scholarships for special library projects. On the subject of library design, he emphasized, like Sir Philip, the importance of having regard to individual circumstances, as well as to the needs of the reader, and commended specially the provision of some rooms for special collections. He stressed particularly the principle that the university library is equally for masters and scholars, and that students should have as free access as any other readers. He does not think that the division into a scholars' library and a masters' library, from which scholars are excluded, is sound; the aim should be to let the student feel that he is a member of a scholarly community and that he is welcome and his place is honourable.

Among the other papers presented to the conference, three were of particular interest to the scientist. They dealt with the general theme, "The Library in the Community", that of Mr. W. S. Haugh (city librarian, Bristol) reviewing the public library service in general. Mr. Haugh said that only fifteen English municipal authorities serving populations in excess of a hundred thousand exceeded 1*s.* 6*d.* per head of population in their expenditure on books during 1952–53, whereas nine spent less than 10*d.* per head as against the 2*s.* suggested as standard in the centenary assessment brochure. For the counties later figures are available, and seven English county authorities are estimated to exceed 2*s.* per head in 1955–56 and seven others to be spending less than 1*s.* 3*d.* Of more specific interest to the scientific worker and technologist, however, were Mr. Haugh's observations on the importance of adequate expenditure on books in the schools and its bearing on educational efficiency, and what is being done by county libraries and other public library services to improve the facilities for educational reading for children as well as for students of technology and of other subjects. He referred particularly to some recent developments in the provision of technical information services by the public libraries, such as the scheme at Liverpool that provides for an immediate temporary technical library and a permanent technical library at a cost of £270,000; the establishment of technical library facilities at the Speke Branch Library serving the trading estate there, as well as branch technical libraries elsewhere; the extension of the Leeds commercial and technical library; the establishment of a separate technical department at Rugby; and the formation at Luton, where the central library maintains a large file of information on the requirements of the export trade, of the Luton and District Technical Information Service. He also mentioned the installation earlier this year in the Manchester Central Library of a teleprinter apparatus giving a direct link to more than a hundred users in the Manchester area, two thousand in the United Kingdom and twenty-five thousand in twenty-one centres abroad, and to the formation of co-operative industrial and commercial reference and information services among public libraries and business firms both in the West London and the North London areas.

Of the other two papers, Mr. H. Thompson (technical librarian, Lancashire County Library), dealing with technical library services in the county, described more particularly the nature of this service, emphasizing its bearing on technical education, and the importance both of mobility and of taking full account of the various requirements of the groups served. Mr. D. J. Foskett (librarian and information officer of the Metal Box Co., Ltd.), dealing with special libraries, also referred to co-operation in the technical field, and his paper was particularly valuable for emphasizing the necessity in all such schemes of remembering that the special library owes its first responsibility to the group by which it is maintained. If this is ignored, the special library can scarcely make its contribution either in co-operation or in the development of new techniques and improved services.

ROTHAMSTED EXPERIMENTAL STATION

REPORT FOR 1954

WITH the advent of any new agricultural problem that is amenable to scientific treatment, it has become almost a matter of course for the interested parties to ask: "What is Rothamsted doing about it?" Clearly it is impossible for any research station to follow up too many of the problems of the moment without dangerous dispersal of effort and neglect of fundamental aspects. It is therefore heartening to see that the annual report of the Rothamsted Experimental Station (Pp. 242, 7*s.* 6*d.*, from Rothamsted Experimental Station, Harpenden) again reflects a most satisfactory balance between pure and applied research and in the choice of the problems being studied. It is also clear from the very large number of visitors from all parts of the world that the Station continues to play a vital part in the exchange of information.

In the Physics Department there have been further advances in the techniques for measuring microclimates, and these methods are being used to study the conditions affecting the spread of virus diseases and of blight in potatoes. A new sodium-saturation test has been used to assess the increase in crumb cohesion caused by certain high polymers. It is interesting to note that some of these are more effective on acid than on calcareous soils. Work continues on the crystal structure of kaolinite.

Notable among a wide range of studies in the Chemistry Department are experiments on the placing of fertilizers. It has been demonstrated that some crops, including potatoes, benefit from the placing of nitrogen and potassium as well as phosphorus. Important progress has been made in the estimation of ammoniacal and nitrate nitrogen in soils, and fundamental studies are being made of

mineral phosphates and of organic nitrogen and phosphorus compounds in soils.

The Pedology Department is closely linked with the Soil Survey and, in collaboration with the latter, a study has been made of the mineralogy of sand and clay fractions from a wide range of soils from Great Britain and the Colonial Territories. This work is providing important data on soil formation and classification. Progress is being made with the survey of trace-element distribution in British soils, and work continues on the effects of leaf leachates in soil-forming processes.

Investigations on the possibility of controlling disease fungi by antagonistic micro-organisms are in progress in the Soil Microbiology Department. It has now been shown that the action of Actinomycetes in suppressing the root fungus *Helminthosporum* is antibiotic and not merely competitive. Work continues on the strains of clover nodule bacteria which fail to produce effective nodules, and attempts are being made to select genetically stable strains for seed inoculation.

Studies in the Botany Department include the mutual interaction of iron and other micro-nutrients, the uptake of nutrients by plants through the leaves and by excised roots, and the physiological effects of virus infections. Work on kale has shown that there is an optimum leaf area, per unit area of land, for dry-matter production. If this is exceeded, efficiency falls off due to the mutual interference of leaves. Studies on weeds continue, with special attention being paid to wild oats.

The Biochemistry Department is mainly concerned with the study of representative enzyme systems, special attention being paid to the enzymes of bracken in the hope that measures of control may ultimately result. Various oxidation systems are also being studied, and progress has been made in designing a press for the large-scale extraction of protein from fresh leaves.

Work in the Plant Pathology Department seems to indicate that, in newly inoculated leaves, virus particles are continually synthesized and broken down and that the ratio of breakdown to synthesis increases with temperature. Among much other interesting work on virus diseases, it has been shown that the incidence of yellows in sugar beet is much reduced by systemic insecticides. Mycological studies have been carried out in relation to a number of crops, and the value of soaking sugar-beet seed in ethyl mercury phosphate has again been emphasized.

In the Nematology Department intensive study is being made of eelworms, their relationships to host plants and the conditions under which populations build up. Surveys at Rothamsted show that increases of eelworm cysts on plots under continuous mangolds and sugar beet have been very slight during the past eight years, but that the highest densities are associated with manurial treatments giving the highest yields.

Research has continued in the Insecticides Department on the mode of action of organo-phosphorus insecticides and, in particular, on their interaction with the esterase systems of various insects. Useful work is reported on practical methods for controlling black aphis on beans and the wheat bulb fly, and progress has been made in rearing the latter in the laboratory.

The biology of the wheat bulb fly is also being studied in the Entomology Department. Work continues on the dispersal of aphids and on the biology of their natural enemies. Interesting studies of gall midges of various plants are reported, in particular the Hessian fly and the midges of white clover, the latter being especially important in relation to the production of clover seed.

The Bee Department once again presents a fascinating research report on foraging habits and social organization. It has been shown that the foraging of bees may be induced by the release in the hive of a scent which they have learnt to associate with food, and this may have great importance in problems of directing bees to particular crops. The sharing of sugary substances collected by one bee with the other members of a colony (using syrup containing carbon-14), the nature and functions of 'queen substance' and trials of acaricides are among other studies reported.

An electronic computer has now been installed in the Statistics Department, and an intensive study is being made of its potentialities. The survey of hill and livestock-rearing farms is complete and will indicate what scope exists for further expenditure on upland farms. Surveys of fertilizer practice and rabbit damage continue.

The report closes with two useful review articles on "Clay Minerals" and on "The Uptake of Nutrients from Leaf Sprays by Agricultural Crops".

EAST MALLING RESEARCH STATION

REPORT FOR 1954

THE forty-second annual report, for 1954, of the East Malling Research Station, near Maidstone, Kent (170 pp., 12*s*. 6*d*. post paid from the Station), includes two general papers of particular interest. The first is the text of the seventh Amos Memorial Lecture, by Prof. T. A. Bennet-Clark, who reviews various concepts of the mechanism by which water ascends large trees, showing that this is not yet fully understood, and makes a plea for more research on the matter. The second is by S. C. Pearce and D. W. P. Greenham, and is a history of the Station's land in the parish of East Malling. It has been possible to trace certain land uses as far back as A.D. 1411, and such historical investigations might achieve useful correlation with modern soil survey.

Malling types of apple rootstocks are now famous, and H. M. Tydeman gives a most useful summary of the twenty-four types, and also crab *C*. His text is very short, but five tables and thirty-five excellent half-tone illustrations give very detailed information about winter and summer characters. D. W. Way, E. S. J. Hatcher and R. J. Garner have investigated the propagation of rootstocks by means of root cuttings. Position on the original root system, length, moisture relations, depth of planting, and various methods of coating the cut ends, have all been assessed, and detailed results are presented. The two last-mentioned workers have also experimented with propagation of Malling crab *C*, by sphæroblast cuttings. Sphæroblasts are rounded swellings on woody stems which are able to produce shoot buds—sufficient to yield some twenty-five hardwood cuttings per maiden tree. The peach variety Hale's Early is compatible with a Brompton rootstock, though not

with Myrobalan *B*. Barbara Mosse shows that on a tree successfully established on a Brompton rootstock, incompatibility was induced by ring-grafting the Brompton stem with Myrobalan *B* bark, and the histology of the union is described. Papers on varietal performance and fruit management include two papers by A. P. Preston, on the results of variety trials of black currants over seven years, and an assessment over nine years of two systems of pruning the crop. Dorothy J. Wilson has measured the loss in yield due to the genetic conditions of Auchincruive Climax known as transient yellows and 'streak'. M. M. McNeill finds that apples grown in pots under glass require applications of dried blood to supplement the normal John Innes potting compost. D. W. Way and G. H. Freeman have bravely undertaken a very careful tasting trial of strawberries and raspberries, with results which are, nevertheless, somewhat of a surprise—at least to the present writer. Temperatures during night frosts were higher over compacted ground than over loose soil, according to C. H. W. Slater and J. P. Ruxton.

It is important that materials for the control of pests should not themselves cause damage, but H. W. B. Barlow, G. H. L. Dicker and J. B. Briggs found that parathion sprays against apple sawfly caused marked fruit drop. Yet parathion gave more significant increases in yield than gamma-benzene hexachloride and nicotine. Such increases were not due to control of the sawfly, and the mechanism by which they were obtained requires further investigation. H. W. B. Barlow, C. R. Hancock and H. J. Lacey have isolated certain heat-stable growth-inhibiting substances from woody shoots of crab *C* and Myrobalan *B* rootstocks. Changes in mineral nutrients in the leaves of the 'biennial bearer' apple Miller's Seedling were investigated by A. C. Mason, who has shown that larger concentrations of nitrogen, phosphorus, magnesium, calcium and manganese occur in the fruiting years than in the non-fruiting ones. A laboratory study by E. L. Frick of thirty materials for their relative ability to inhibit spore germination of *Botrytis cinerea* brought out some interesting divergencies between laboratory and field performance. Two of the substances—tecnazene and pentachlornitrobenzene—are already in use against the fungus, but did not inhibit spore germination. Thiram and the ferric, zinc and manganese dithiocarbamates, moreover, inhibited spore germination at two different concentration ranges.

Leaf roll, a new virus disease of the sweet cherry, is described by A. F. Posnette and R. Cropley. An attempt to clarify the relations between nettlehead and split leaf blotch viruses of hops has been made by J. T. Legg. Evidence for the view that the latter is a component of a complex causing the former is as yet inconclusive; but in this particular field trial, the relevant clones of College Cluster and Malling Midseason had the lowest amount of nettlehead of any variety tested. A. M. Massee contributes fifteen short notes on interesting insect records in 1954, perhaps the most important of which is an attack by cockchafers in two localities. He also reviews problems arising from the use of insecticides, and makes a plea for entomologists to study their effects upon the whole orchard fauna. Joan R. Groves reports that mercury-vapour light traps were found more efficient than bait traps for catching codling moths, while D. A. Chant and R. C. Muir find that the brushing machine method is superior to the imprint method for estimating numbers of fruit-tree red-spider mites. In the realm of statistics, G. H. Freeman and Margaret J. Hall point out that variations in number of red-spider mites from leaf to leaf, between trees, and also between plots, should all be considered when estimating the significance of control treatments.

There are, in the report, also accounts of all the activities of research sections and a description of the organization of the experimental farm. There are weather records and the texts of three bulletins for fruit-growers: on the search for better fungicides, by M. H. Moore; an illustrated description of capsid bugs, by Elsie Collyer; and on some impressions of apple orchard practices in Canada, by G. H. L. Dicker and A. H. M. Kirby. The volume is produced to the usual high standards of printing and illustration, and—most welcome—there is an index.

JOHN GRAINGER

PATHOLOGY OF BIRDS IN ZOOLOGICAL GARDENS

A STUDY of the pathology of birds in the Zoological Gardens of Antwerp has been made by Prof. L. M. G. Geurden, of the University of Ghent (Bulletins de la Société Royale de Zoologie, d'Anvers, No. 4).

Bird diseases in zoological gardens are numerous and mortality is very high. The primary cause may be either in the country of origin or in the transportation, or in the zoological garden itself. In captivity, malnutrition, deficient food or lack of movement influence a large number of birds, although their susceptibility varies within wide limits from one individual to another.

In the period under review, Prof. Geurden dissected thirty-five dead birds; a laboratory analysis was often required for a definitive diagnosis. The most common causes of death were pneumonia (5), visceral gout (13) and hæmorrhagic enteritis (22). Pneumonia, quickly followed by death, is common in birds originating from tropical countries when exposed to low temperature. Isosporosis involving a primary disease is likewise very frequent. Captive birds often suffer from visceral gout; the great change in the way of living and in the nature of the food is doubtless the starting-point of this disease, although the susceptibility of different individuals varies considerably. Diseases such as cæcal coccidiosis and black head will affect all members of the gallinaceous group in the same way.

The majority of birds had died from hæmorrhagic enteritis. In the absence of intestinal parasites, the bacteriological test for detecting *Salmonellae* often shows a negative result. *Salmonellae* were cultivated seven times from the intestinal contents.

Birds are commonly considered as the biggest reservoir of *Salmonellae*; powdered eggs used during the War have shown this on a very large scale. In some cases latent infections occur, in others acute diseases develop. Although several internal organs may be the seat of these infections, they are more often found in the intestines and in the genital organs. Owing to the large number of *Salmonella*-types, the epidemiology of *Salmonella*-infections is quite confused, and, in his work, Prof. Geurden clarifies a number of points which have previously caused difficulties with various species and types.

COMBINED AMINO-ACID CONTENT OF TUMOUR AND HOMOLOGOUS NORMAL TISSUE

By Dr. G. C. EASTY and Dr. E. J. AMBROSE

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In the course of an investigation into the chemical and structural difference between tumour and homologous normal tissue, the combined amino-acid content of the normal kidneys of the male golden hamster was compared with that of tumours produced in them by treatment with stilbœstrol. This material is particularly convenient for such a study, since the tumours are very compact, consisting almost entirely of tumour cells, and are easily separated from surrounding non-tumour tissue. All tissue samples analysed were subjected to histological examination. Fourteen amino-acids were analysed by paper chromatography, using mainly the method of Roland and Gross[1], and to a lesser extent McFarren and Mills[2].

Initially, all hydrolyses were carried out in tubes sealed in air with 10 *N* hydrochloric acid, and a tumour hydrolysate was first compared with that of a whole normal kidney. The proportion of methionine in the tumour was 30–40 per cent lower than in the normal kidney, the other thirteen amino-acids being present in both tissues in almost identical proportions. The tumours arise from the cortex of the kidney, and it was thought possible that the cortex of the normal kidney might contain less fixed methionine than the inner medulla. This could account for the lower proportion of methionine in the tumour arising from the cortex. To test this a second tumour was compared with the normal cortex, normal medulla, and cortex adjacent to the tumour but free of any visible tumours. From the results in Table 1 it can be seen that, relatively, the cortex of the normal kidney contained if anything slightly more methionine than the medulla. Hence the decrease in methionine content of the tumour was not due to its being derived from the cortex. Furthermore, the methionine content of the tumour-free cortex of the tumour-bearing kidney was the same as that of the cortex of the normal kidney. A hamster kidney cortex, which had not formed tumours on treatment with stilbœstrol under the conditions which gave rise to tumours in other hamsters, contained the same proportion of methionine as the normal untreated kidney. Thus it appeared that a lower content of combined methionine is characteristic of this tumour. Significantly lower quantities of tyrosine were found in the tumour compared with most of, but not all, the other tissues; but the deficiency was not so great. Ten tumours have been analysed so far, most of them at least twice, and in no case has the methionine content failed to be less than that of the whole normal kidney, cortex and medulla.

Tissues to be compared were so far as possible obtained at the same time, fixed as soon as possible by immersion in 3 volumes of ethyl alcohol and 1 volume of glacial acetic acid, or in absolute ethyl alcohol alone for one hour, washed with absolute ethyl alcohol and stored in that solvent. The chopped samples were extracted for equal lengths of time with chloroform to remove lipids, dialysed in the same vessel to remove low-molecular weight compounds, and equal weights sealed in tubes containing hydrochloric acid, either with enclosed air or evacuated; they were hydrolysed at 110° in an oven, side by side, for 18 hr. Two analyses of one hydrolysate on the same sheet of paper almost always agreed to within ±5 per cent for each amino-acid, and hydrolysates to be compared were always run on the same sheets.

On comparison with previous analyses for kidney and liver, it was found that we were obtaining lower values for the quantities of methionine and tyrosine present. As most previous workers had hydrolysed their tissues in 6 *N* hydrochloric acid and not 10 *N*, it was thought that lower values might be due to more extensive degradation of these amino-acids by the more concentrated acid. On hydrolysis of the same sample of normal kidney with 6 *N* and 10 *N* hydrochloric acid in sealed tubes with air it was found, however, that as much loss of tyrosine and

Table 1. Relative Concentrations of each Amino-acid present in each Pair of Tissue Hydrolysates, Aspartic Acid being taken as 1·00, and the Values for the other Amino-acids adjusted accordingly. Last Three Columns with Identical Material

	Tumour/whole normal			Tumour*/ cortex from tumour-bearing kidney	Tumour*/ normal cortex	Tumour*/ stilbœstrol cortex (no tumours)	Normal cortex*/ normal medulla	Tumour†/ whole normal	Tumour*/ normal	(Same tumour + methionine*)/ (same normal + methionine)
Aspartic acid	1·00			1·00	1·00	1·00	1·00	1·00	1·00	1·00
Glutamic acid	0·93			1·04	1·00	1·05	1·00	1·02	0·96	0·95
Serine	0·94			0·94	0·80	0·79	1·03	0·98	0·88	0·92
Glycine	0·90			1·12	1·15	1·21	0·98	1·01	0·97	0·99
Threonine	0·95			0·92	0·97	0·90	1·00	0·96	1·02	0·96
Alanine	0·93			1·01	0·95	1·01	1·09	0·99	0·98	1·01
Lysine	0·92	0·94	1·00	1·09	0·93	0·96	1·15	0·94	1·00	1·01
Arginine	0·96	1·00	0·93	1·15	0·97	1·04	1·09	0·97	0·97	0·96
Proline				1·00	1·09	0·97		0·96		
Tyrosine	0·96		0·95	0·76	0·73	0·88	1·08	0·94	0·64	0·66
Valine	0·90	0·96	0·94	0·97	0·95	0·88	1·13	0·93	0·97	0·95
Methionine	*0·58*	*0·61*	*0·66*	*0·62*	*0·65*	*0·60*	*1·22*	*0·94*	*0·51*	*0·82*
isoLeucine	1·00			0·95	0·91	0·95	1·02	0·96	0·98	0·99
Leucine	1·01			1·02	1·06	0·90	1·06	0·98	1·01	0·95

* All hydrolysed in sealed tubes with air.

† Hydrolysed *in vacuo*.

methionine occurred in 6 *N* acid as in 10 *N* acid. But it was found that when the same sample was hydrolysed in 6 *N* or 10 *N* acid *in vacuo*, the values for methionine and tyrosine rose, and they compared favourably with those obtained by previous workers. It appears that the presence of air rather than the concentration of acid is causing the loss of methionine and tyrosine.

Of greater importance was the observation that, when hydrolysed *in vacuo*, the normal and tumour tissues contained on analysis equal quantities of methionine and tyrosine. There are several possible explanations for the observed and consistent difference in the degree of degradation of individual amino-acids present in normal and tumour tissues hydrolysed side by side under identical conditions.

(1) The tumour tissue could contain more of certain contaminating substances such as nucleic acids and polysaccharides which might catalyse degradation. The hydrolysis of normal kidney and tumour in the presence of added 10 per cent deoxyribonucleic acid and 10 per cent polysaccharide in 6 *N* hydrochloric acid *in vacuo* was therefore carried out. It resulted in no significant loss of any amino-acid compared with the hydrolysis of these tissues alone under the same conditions. Possible losses of methionine during chromatography caused by the presence of more contaminating substances in the tumour hydrolysate than in the normal hydrolysate were tested for by adding equal known quantities of methionine to both hydrolysates. The recovery of added methionine in both cases was the same, about 90 per cent, that is, a 10 per cent loss, similar in magnitude to that found by Moore and Stein[3] using polystyrene columns.

(2) The tumour tissue might contain more of certain catalysts, such as trace metals, which are known to catalyse the oxidation of methionine. This was investigated by adding equal quantities of methionine to equal weights of tumour and normal tissue before hydrolysis *in air*. If there is no greater loss of the methionine added to the tumour than of that added to the normal tissue, then the difference in degradation observed with normal and tumour tissue alone cannot be caused by catalysts. Thus, if no more catalysis occurs in the tumour hydrolysate than in the normal hydrolysate, then:

Methionine (Normal tissue + added methionine) − Methionine (Normal tissue)

= Methionine (Tumour tissue + added methionine) − Methionine (Tumour tissue)

The figures found, in milimoles, were:

Me (N + A)	− Me (N)	and	Me (Tu + A)	− Me (Tu)
1·4	−0·65 = 0·75		1·15	−0·33 = 0·82

Therefore, the added methionine was degraded to an almost equal extent with both tissues—if anything to a slightly smaller extent in the tumour hydrolysate.

This leaves explanation (3), namely, that there are significant differences in the structure and/or amino-acid sequence of the proteins of the normal and tumour tissues. It is known that free methionine is partially oxidized during acid hydrolysis in the presence of air[4], and it seems probable that the greater loss of methionine and tyrosine in the tumour hydrolysate than in the normal kidney hydrolysate is due to the fact that the tumour proteins are hydrolysed more rapidly, the amino-acids being released more quickly, thus allowing more time for oxidation to occur.

Recent work by Smith and Stockell[5] on the composition of carboxypeptidase has shown that the apparent loss of certain amino-acids on hydrolysis depends on factors which appear to vary with different proteins. In addition, it is now recognized that peptide bonds involving, for example, *iso*leucine and valine are difficult to hydrolyse. Hirs, Moore and Stein[6], in their work on the composition of ribonuclease, found that no decomposition of acidic amino-acids was observed when synthetic mixtures were 'hydrolysed', whereas some loss was observed when ribonuclease was hydrolysed under the same conditions. Similarly, Smith *et al.*[7], found that no destruction of glutamic acid occurred on hydrolysis of carboxypeptidase, but that destruction occurred on hydrolysis of crystalline papain under identical conditions. Differences in the rates of release and degradation of the same amino-acids from tumour and homologous normal tissue might account for different results obtained by different workers on the same materials. Schweigert[8] found that the whole homogenates of tumours obtained from the livers of rats treated with 4-dimethylaminoazobenzene contained 33 per cent less methionine and 28 per cent more cystine than the normal livers. Sauberlich and Baumann[9] carried out similar analyses on the same tumours but found no deficiency of methionine or increase of cystine. The conditions of hydrolysis were not, however, identical in both cases, different concentrations of acid being used for different periods of time.

The suggested greater ease of hydrolysis of tumour proteins under these conditions fits in with the idea put forward by Ambrose[10] that the tumour proteins are characterized by a more random structure which should facilitate attack by hydrolytic and other agents. There is evidence[11] that proteolytic enzymes first act by denaturing the protein, reducing the degree of order. Thus, increased randomness of tumour proteins might facilitate hydrolysis even in acid solution without the intervention of enzymes. It is of interest to recall that Rondoni[12] has suggested that carcinogenesis is accompanied by denaturation of the cell proteins. The observations of Kögl and Erxleben *et al.*[13] concerning the presence of more D-glutamic acid in tumours than in normal tissues, about which there has been much controversy, might be explicable in terms of differences of protein structure leading finally to the isolation of a more highly racemized glutamic acid from the tumour than from the normal tissues.

From our work we conclude that, within the limits of error of the analytical method used, there appears to be no significant difference in the overall amino-acid composition of normal hamster kidney and the tumour induced by stilbœstrol. There is evidence, however, that overall differences of structure of the proteins occur consistently between the normal and tumour tissue. This conclusion is in agreement with that of Cruft, Mauritzen and Stedman[14], who found evidence that the physical properties of histones from malignant cells exhibit pronounced differences from those of normal cells, although there was no difference in the amino-acid composition.

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[1] Roland, J. F., and Gross, A. M., *Anal. Chem.*, **26**, 502 (1954).
[2] McFarren, E. F., and Mills, J. A., *Anal. Chem.*, **24**, 650 (1952).
[3] Moore, S., and Stein, W. H., *J. Biol. Chem.*, **211**, 893 (1954).
[4] Schram, E., Dustin, J. P., Moore, S., and Bigwood, E. J., *Analytica Chemica Acta*, **9**, 149 (1953).
[5] Smith, E. L., and Stockell, A., *J. Biol. Chem.*, **207**, 501 (1954).
[6] Hirs, C. H. W., Stein, W. H., and Moore, S., *J. Biol. Chem.*, **211**, 941 (1954).
[7] Smith, E. I., Stockwell, A., and Kimmel, J. R., *J. Biol. Chem.*, **207**, 551 (1954).
[8] Schweigert, B. S., Guthneck, B. T., Price, J. M., Miller, J. A., and Miller, E. C., *Proc. Soc. Exp. Biol. Med.*, **72**, 495 (1949).
[9] Sauberlich, H. E., and Baumann, C. A., *Cancer Res.*, **11**, 67 (1951).
[10] Ambrose, E. J., *Brit. J. Cancer*, **8**, 259 (1954).
[11] Anaya, S., and Kobayashi, M., *Science (Japan)*, **18**, 269 (1948).
Linderstrøm-Lang, K., *Proc. Roy. Soc.*, A, **170**, 56 (1939).
[12] Rondoni, P., *Enzymologia*, **9**, 380 (1941).
[13] Kögl, F., and Erxleben, H., *Z. physiol. Chem.*, **258**, 57 (1939).
Chibnall, A. C., Rees, M. W., Tristram, G. R., Williams, E. F., and Boyland, E., *Nature*, **144**, 71 (1939).
[14] Gruft, H. J., Mauritzen, C. M., and Stedman, E., *Nature*, **174**, 580 (1954).

SIGNIFICANCE OF GLUTAMIC ACID IN METABOLIC PROCESSES IN THE RAT BRAIN DURING PHYSICAL EXERCISE

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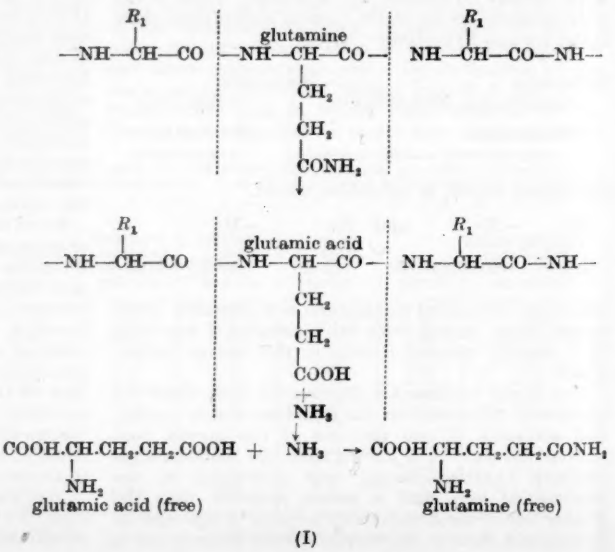
PHYSICAL exercise is associated with an increased functional activity of large areas of brain, since, during physical exercise, impulses are sent to peripheral organs, signals come back from proprioceptors, and simultaneously the nerve centres are in action which co-ordinate the internal organs, the blood circulatory system, the respiration, etc., with active muscles. We consider the diffuse neuromuscular activity an appropriate model of the increased functional activity of the brain nervous tissue. The functional activity of the nervous tissue is always associated with the formation of ammonia[1]. In our previous experiments we found that during physical exercise the ammonia formed in the brain is bound in the form of glutamine[2]. Simultaneously with this process, the splitting of ammonia off amide bonds of proteins of the brain nervous tissue takes place[3]. On the basis of these experiments we assume that during functional activity of the brain associated with the performance of physical exercise, metabolic processes as shown in scheme (I)[2] take place in the brain nervous tissue.

This scheme is supported by the following facts: (1) during functional activity of rat brain nervous tissue, a decrease of the actual concentration of the amide group in the brain protein fraction occurs[2]; (2) as has been described many times, during functional activity of the nervous tissue ammonia is formed[1]; (3) during functional activity of the brain nervous tissue in association with physical exercise, an increase of the actual concentration of free glutamine in the brain takes place[2]; (4) functional activity of the nervous tissue is associated with structural changes in the nervous tissue proteins[3].

One of the further assumptions of this scheme is that with the increase of the concentration of free glutamine in the brain a decrease in the concentration of the free glutamic acid in the brain during physical exercise should take place. The correctness of this assumption has now been examined experimentally.

The experiment was performed on 72 rats weighing 150–200 gm., which were divided into six experimental series. Each experimental series contained twelve rats of approximately the same weight and age. Each experimental series of twelve rats was divided into two groups of six animals. One group swam for 4½ hr. under conditions described previously[2]. The swimming served us as a model of diffuse neuromuscular activity. The second group served as controls. After the cessation of swimming, the rats both of the experimental and the control group were thrown into liquid air and frozen *in vivo*. The frozen brains of the experimental animals were dissected, homogenized to powder by crushing at low temperature and put in a weighed flask containing 100 ml. of 12 per cent trichloroacetic acid. Into a second flask the brains of animals of the control group were put in the same way. The wet weight of the brains was determined by differential



(I)

weighing. The trichloroacetic acid was then filtered off, and the rest of the tissue was extracted three times with 50 ml. of 12 per cent trichloroacetic acid solution. From the combined trichloroacetic extract, after removal of glutamine and trichloroacetic acid, an aqueous solution of amino-acids contained in the acid-soluble rat brain fraction was prepared according to the method of Ansell and Richter[4]. This aqueous solution was used for the chromatographic separation of amino-acids. On the chromatographic paper, 15-μl. volumes of the aqueous amino-acid solution were applied, which corresponds to 30 mgm. of wet brain tissue. Under our conditions of chromatography, no desalting procedure was necessary.

As shown in the paper of Fischer and Dörfel[5], only one-dimensional chromatography is suitable for quantitative determination of amino-acids on paper. Amino-acids of the control and the fatigued group of one experimental series were applied on a sheet of filter paper Whatman No. 1, using always on one paper four samples of the control group of a series and four samples of the fatigued group of the same series, alternately. The amino-acids were separated one-dimensionally by repeated (10–12 times) descending chromatography with a butanol/acetic acid/water mixture[6]. After complete separation of amino-acids, which takes about a fortnight, the chromatogram was developed by ninhydrin, photographed on microfilm and the microfilm evaluated microphotometrically on a Soviet microphotometer (*MF*-2). For the separation and the quantitative evaluation of amino-acids, the method described by Keil[6] was used with slight modifications.

Fig. 1 represents a chromatogram of one experimental series (series No. 5). The sample of the experimental group is marked with the letter N_1 (first column from the left), next is the sample of the fatigued group, marked with the letter P_1 (second column from the left). Then follows the sample of the control group (N_2) and again a sample of the fatigued group (P_2). In the middle of the chromatogram, a sample of ovalbumin hydrolysate (O) is applied, the composition of which is known, and which is applied for the identification of amino-acids. To the right from the ovalbumin sample are again applied alternately the sample of the control and the fatigued group (N_3, P_3, N_4, P_4).

Fig. 2 gives a typical microphotometric evaluation (column N_2 and P_2 from chromatogram No. V) of our chromatograms. The 'spectra' of the free amino-acids of the control group are drawn with a full line,

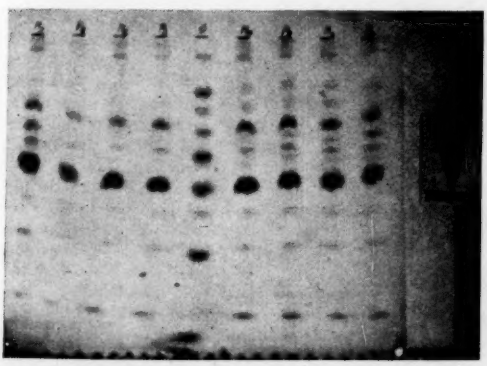


Fig. 1

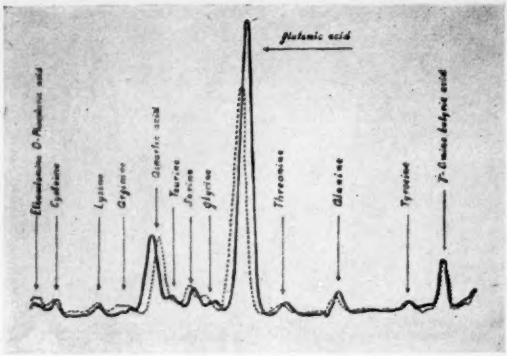


Fig. 2

and the dotted line corresponds to free amino-acids in the brains of the fatigued group of animals. Each maximum corresponds to one amino-acid, and the area below the maximum is proportional to the concentration of the respective amino-acid. The difference between the control and the fatigued group is shown by the fact that in the acid-soluble fraction of brains of the fatigued group the concentration of glutamic acid is always lower than in the control group. The curves were checked planimetrically. As to the rest of the amino-acids, their concentration either does not change during physical exertion, or minute variations upwards or downwards appeared, as is usually the case with biological materials. The concentrations of the free glutamic acid, however, were in all six experimental series lower in the brains of the fatigued animal group in comparison with the respective control group ($P < 0{\cdot}01$). From each experimental series four parallel pairs of curves of the 'spectra' of amino-acids of both the control and the fatigued group were constructed on one chromatogram. The results fully confirm our previous assumption[2] that during the functional activity of brain nervous tissue in association with the performance of physical exercise a decrease of the concentration of free glutamic acid in the rat brain takes place. One of the effects of the participation of glutamic acid in this physiological process is the increase of the concentration of free glutamine[2]. A logical conclusion from this fact would be that during the restitution period (that is, during rest after physical exertion) a decrease of the glutamine concentration in the brain should take place. This assumption has been proved experimentally.

The experiment was carried out on eighty-four rats weighing 120–160 gm. each, which were divided into seven experimental series of twelve animals each. The twelve animals of one experimental series swam for 4½ hr. under the conditions described previously[2]. After the cessation of swimming, the twelve experimental animals were divided into two groups of six animals each. One group, the controls, was killed at once, the other group was killed after a rest period of 20 hr. Glutamine was determined in the average sample of brains of the fatigued and the rested group by the modified method of Richter and Dawson[1]. The results are given in Table 1.

The experimental results confirm that, during rest after physical exertion, a statistically significant decrease of the free glutamine concentration in the rat brain takes place. This result confirms, and

Table 1. Effect of Rest on the Free Glutamine Concentration in the Rat Brain
(Each number represents a pooled sample of six brains, determined in each case by four parallel determinations. The results are expressed in μmoles amido-N/gm. wet brain tissue*)

Series	After 4½ hr. swimming (A)	After 4½ hr. swimming + 20 hr. rest (B)	Difference (B − A)	Difference in %
1	12·4	9·6	− 2·8	− 22·6
2	7·95	7·75	− 0·2	− 2·6
3	7·6	7·2	− 0·4	− 5·3
4	9·7	8·35	− 1·35	− 13·9
5	8·5	8·0	− 0·5	− 5·9
6	11·1	10·8	− 0·3	− 2·7
7	11·8	9·1	− 2·7	− 22·9
			− 1·18 ± 0·43 $P < 0·05$	

* The values are not corrected for the free ammonia. During physical exertion no changes of the concentration of free ammonia in the rat brain take place (ref. 2). Maximal error of the method is 2–3 per cent

completes at the same time our previous findings[4], that during physical exercise an increase of the actual concentration of the free glutamine in the rat brain takes place.

The question is raised, however, of the significance of the free glutamine in the brain during rest. The glutamine in the brain is not only the form in which ammonia is transported for excretion from the organism, but it has also another role[7]. In recent years, the great importance of glutamine for the synthesis of polypeptides and proteins has been clarified in a series of papers[8]. In one of our previous papers we examined the effect of physical exertion on the Kjeldahl-nitrogen concentration in the protein fraction of the brain. (By the term 'protein fraction' we understand the rest of the nervous tissue of the rat brain after extraction with trichloroacetic acid and removal of lipids by extraction with organic solvents[2].) The results of this experiment are given in Table 2.

Table 2. Effect of Physical Exertion on the Kjeldahl-Nitrogen Concentration in the Rat Brain Protein Fraction

Series	Normal (A)	After 4½ hr. swimming (B)	Difference (B − A)
1	1116·7	1108·4	− 8·3
2	1002·6	931·1	− 71·5
3	1072·8	978·1	− 94·7
4	958·7	936·7	− 22·0
5	958·6	987·6	+ 29·0
6	1040·3	1014·1	− 26·2
	1024·9	992·7	− 32·2 ± 18·1 $P < 0·1$

In the course of physical exertion, a decrease in the average concentration of Kjeldahl-nitrogen from 1024·9 μmoles/gm. to 992·7 μmoles/gm. of wet weight brain tissue took place. The difference was −32·2 ± 18·1 μmoles/gm. This decrease is not statistically significant, and we could therefore only state that, on the basis of these figures, we did not find a statistically significant decrease of the Kjeldahl-nitrogen in the brain protein fraction during physical exertion[2].

There is, however, a tendency towards decrease of the Kjeldahl-nitrogen during physical exertion. In six experimental series, each containing twelve experimental animals, a decrease of the Kjeldahl-nitrogen in the brain protein fraction occurred in five cases. We decided, therefore, to study this phenomenon further. Other experimental series were so arranged that all experimental animals were allowed to swim for 4½ hr. Some were killed immediately after cessation of this physical exertion, the others after resting for 20 hr. If the tendency

Table 3. Effect of Rest after Physical Exercise on the Kjeldahl-Nitrogen Concentration in the Rat Brain Protein Fraction

Series	After 4½ hr. swimming (A)	After 4½ hr. swimming + 20 hr. rest (B)	Difference (B − A)
1	889·3	939·3	+ 50·0
2	850·0	900·0	+ 50·0
3	872·9	935·7	+ 62·8
4	983·6	985·7	+ 2·1
5	960·7	986·2	+ 25·5
6	989·3	1064·3	+ 75·0
	924·3	968·5	+ 44·2 ± 10·8 $P < 0·01$

The method we used for Kjeldahl-nitrogen estimation was strictly checked, and it was found that the maximum error of estimation was less than 1 per cent

to decrease in the actual concentration of Kjeldahl-nitrogen in the protein fraction of rat brain during physical exertion, as seen in Table 2, is not incidental, then we would expect the protein fraction of rat brain of animals rested after physical exertion to show an increase in the Kjeldahl-nitrogen concentration, in comparison with that of the brain protein fraction of rats killed immediately after physical exertion. The results of this experiment are shown in Table 3.

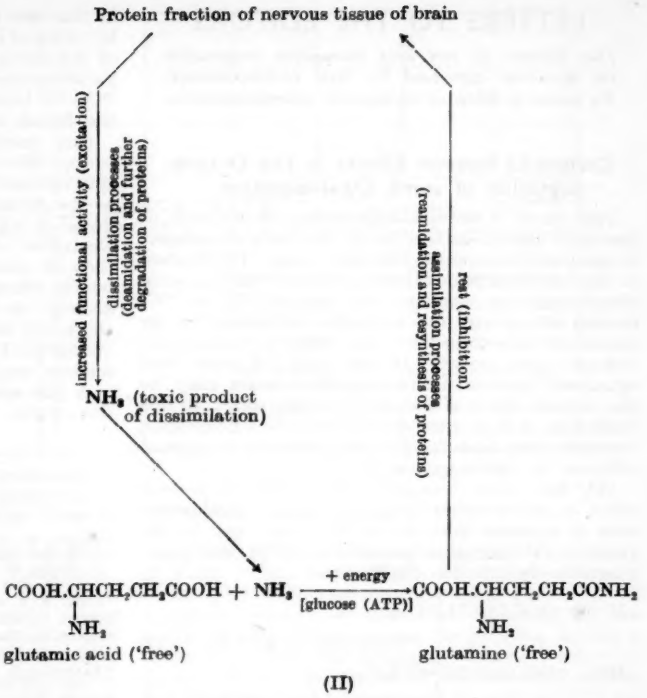
From Table 3 it is apparent that an increase of the Kjeldahl-nitrogen in the brain fraction of experimental rats takes place in all six series during rest after physical exertion. The difference (+ 44·2 ± 10·8 μmole Kjeldahl-nitrogen/gm. wet brain tissue) is statistically significant ($P \sim 0·01$).

On the basis of the results in Tables 2 and 3, we conclude that during the functional activity of the brain nervous tissue in association with physical exertion, a decrease of the Kjeldahl-nitrogen concentration in the rat brain protein fraction occurs, whereas during rest an increase takes place.

Recently it was shown, using ^{35}S-methionine, that the metabolic activity of brain proteins is relatively high[9]. Similarly, the cytochemical studies of Hydén showed that the protein and polynucleotide content of the nervous tissue changes during functional activity of the nervous tissue[10]. Our experimental results also show that the metabolic activity of brain proteins is relatively high, and that the processes of functional activity of nervous tissue are associated with metabolic processes in the protein fraction of the brain nervous tissue. During increased functional activity, dissimilation processes are predominant in the protein fraction of the brain nervous tissue, whereas during rest, assimilation processes prevail in this fraction.

On the basis of experimental results given in this and the previous papers, we believe that the following scheme of the chemical processes in the brain provides a working hypothesis: (1) During the functional activity of the brain nervous tissue a degradation of nitrogen substances in the brain protein fraction takes place. One of the first processes indicating the participation of the proteins in the functional activity of the brain nervous tissue is the splitting of the amide-nitrogen off the polypeptidic chain of proteins of the brain nervous tissue. During these degradation processes, ammonia is formed; and the processes mentioned above may be the cause of the well-known fact[1] that the functional activity of the nervous tissue and the formation of ammonia are closely related. (2) Ammonia formed during the functional activity of the brain nervous tissue is a toxic product to the nervous tissue, and it is bound in the brain *in vivo* by

the free glutamic acid. This process is manifested by the increase of the concentration of the free glutamine during increased functional activity of the brain nervous tissue in association with diffuse neuromuscular activity[2] and a decrease of free glutamic acid concentration. (3) The free glutamine formed during functional activity of the brain nervous tissue is not only a detoxication product serving for the excretion of ammonia; it is also the basis for the resynthesis of the high-molecular nitrogen-containing substances in the brain nervous tissue during rest. This is shown by the fact that during rest a decrease of the free glutamine in the brain takes place which is associated with the parallel increase in the concentration of Kjeldahl-nitrogen in the brain protein fraction. (4) The functional activity and the rest of the brain nervous tissue are chemically related as a cyclic process of degradation and resynthesis of the protein fraction of the brain nervous tissue. In this cyclic process, the free glutamic acid and the free glutamine occurring in the brain in molecularly dispersed form have an important role. The free glutamic acid has great significance in the final phase of the degradation process of the cyclic changes of brain nervous tissue proteins, as an intercepting link for ammonia, this being the final product of this degradation phase. During this process free glutamine is formed from the free glutamic acid, which is simultaneously an initial link for the phase of resynthesis. The free glutamic acid and the free glutamine represent in the brain a system lying at the turning point for degradation and resynthesis of the protein fraction of brain nervous tissue, and connecting the catabolic and anabolic processes in the brain nervous tissue. The increased functional activity of the brain is characterized by catabolic processes, the decreased functional activity (rest) by the predominance of anabolic processes in the protein fraction of the brain nervous tissue.



(II)

From the formulation of points 1 to 4 results our view of the unity and close relation of the processes of excitation and inhibition from the chemical point of view. During excitation, dissimilation processes in the brain nervous tissue are predominant, but simultaneously also synthetic processes are taking place. During inhibition, synthetic processes predominate, but simultaneously dissimilation processes also take place. The chemical basis of the processes of excitation and inhibition appears to us, in the light of our experiments, as a shift of the equilibrium to one side or the other.

Our findings are in good agreement with the conceptions of I. P. Pavlov, and provide concrete evidence supporting the hypothesis formulated by him in the following way: "The process of inhibition is probably associated with assimilation, similarly, the process of excitation is naturally associated with dissimilation"[11] (inhibition in Pavlov's terminology is understood as an active process).

We wish to emphasize, however, that the chemical basis of the process of excitation and inhibition is undoubtedly represented by a wide complex of chemical processes, and the scheme we have suggested can be only considered as a contribution to the partial clarification of these processes. Similarly, the participation of glutamic acid in the chemical processes associated with the functional activity of the brain nervous tissue cannot be limited only to the chemical process described above.

I wish to thank Mrs. Rosa Ehrmann, Mr. J. Karaus and Mr. J. Veselý for assistance in the experimental work.

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[1] Tashiro, S., *Amer. J. Physiol.*, **60**, 519 (1922). Winterstein, H., and Hirschberg, E., *Biochem. Z.*, **156**, 138 (1925). Rösch, H., and TeKamp, W., *Hoppe-Seyl. Z. physiol. Chem.*, **175**, 158 (1928). Pravdič-Neminskij, V., *Arch. biol. Nauk*, **33**, 121 (1933). Richter, D., and Dawson, R. M. C., *J. Biol. Chem.*, **176**, 1199 (1948). Budanova, A. M., *Doklady Akad. Nauk SSSR.*, **85**, 875 (1950). Vladimirova, E. A., in "Biochimija nervnoj sistemy" (Izd. Akad. Nauk. Ukr. SSR, Kiev, 1954).

[2] Vrba, R., *Physiol. Bohemoslov.*, **3**, 122 (1954); **3**, 394 (1954); **4**, 400 (1955); *Nature*, **176**, 117 (1955).

[3] Nasonov, D. N., and Alexandrov, V. J., "Reakcija živogo veščestva na vnešije vozdestvija" (Izd. Akad. nauk SSSR, 1941). Ushakov, V. P., *Usp. sovr. biol.*, **38**, 294 (1954). Romanov, S. N., *Dokl. Akad. Nauk* SSSR., **90**, 117 (1953). Zarakovskij, G. M., and Levin, V. S., *Fiziol. zurn.* SSSR., **39**, 81 (1953). Segal, J., *Z. Humboldt Univ. Berlin*, **3**, 243 (1953/1954). Frank, G. M., *et al.*, in "Biochimija nervnoj sistemy" (Izd. Akad. Nauk Ukr. SSR., Kiev, 1954).

[4] Ansell, G. B., and Richter, D., *Biochem. J.*, **57**, 70 (1954).

[5] Fischer, F. G., and Dörfel, H., *Biochem. Z.*, **324**, 544 (1953).

[6] Keil, B., *Coll. Czech Chem. Commun.*, **19**, 1006 (1954).

[7] Richter, D., Brain Metabolism. I. International Neurochemical Symposium (Academic Press, New York, 1955).

[8] Hanes, C. S., Hird, F. J. R., and Isherwood, F. A., *Nature*, **166**, 288 (1950). Fruton, J. S., Johnston, R. B., and Fried, M., *J. Biol. Chem.*, **190**, 39 (1951). Waelsch, H., *Naturwiss.*, **40**, 404 (1953); "Adv. Enzymol.", **13**, 238 (1952).

[9] Galtonde, M. K., and Richter, D., *Biochem. J.*, **59**, 690 (1955). Palladin, A. V., and Wertheimer, N., *Dokl. Akad. Nauk SSSR.*, **102**, 319 (1955).

[10] Hydén, H., *Symp. Soc. Exper. Biol.*, **1**, 152 (1947).

[11] Pavlov, I. P., XIV International Physiological Congress, Sept. 2, 1932, Rome.

LETTERS TO THE EDITORS

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Carbon-13 Isotope Effects in the Decarboxylation of some Oxaloacetates

The effect of isotopic substitution on the rate of fission of carbon–carbon bonds has been the subject of many studies over the past eight years. The balance of the experimental evidence indicates that for some decarboxylation reactions the ratio of ^{14}C- to ^{13}C-isotope effects may not be readily accounted for by statistical rate-theory on the basis of changes in isotopic mass alone[1]. It has been suggested that apparently anomalous isotope-effect ratios may be due to some effect of carbon-13 nuclear spin[2]. In this connexion, it is of interest that some decarboxylation reactions have been found to be catalysed in aqueous solution by paramagnetic ions[3–5].

We have now measured the carbon-13 isotope effect in the decarboxylation of 'natural' oxaloacetic acid in aqueous solution at 25°, alone, and in the presence of diamagnetic yttrium (Y^{3+}) and paramagnetic dysprosium (Dy^{3+}) ions.

$$(M^{3+}),\ {}^{-}OOC.COCH_2\big|{}^{12}COO^{-} \rightarrow {}^{-}OOC.COCH_3 + {}^{12}CO_2 \quad (1)$$

$$(M^{3+}),\ {}^{-}OOC.COCH_2\big|{}^{13}COO^{-} \rightarrow {}^{-}OOC.COCH_3 + {}^{13}CO_2 \quad (2)$$

M^{3+} represents Y^{3+} or Dy^{3+}.

The effluent carbon dioxide was analysed with a Metropolitan-Vickers *MS*-2 mass-spectrometer, and the ratio of the rate constants for reactions (1) and (2) was calculated from the measurements of carbon-13 dioxide to carbon-12 dioxide ratios at 5 per cent and at 10 per cent decarboxylation (with the measured ratio for 100 per cent reaction).

Carbon-13 Isotope Effects at 25°

	Oxaloacetic acid ($pH = 1$)	Y^{3+} oxaloacetate	Dy^{3+} oxaloacetate
$100\left(\frac{k_{12-12}}{k_{12-13}} - 1\right)$	6	5 ± 1	10 ± 1

The mass-spectrometer was not used at its highest level of accuracy, but the above preliminary values show that there is a definite 'magnetic' isotope effect, well in excess of any probable error.

At pH = 1, in the absence of added trivalent ions, the carbon dioxide comes in approximately equal amount from undissociated acid and monovalent anion[5]. The isotope effects for these two species are not expected to differ greatly[6], and this is supported by the reasonable agreement with the isotope effect for yttrium oxaloacetate. The experiments in the presence of trivalent ions were so designed that decarboxylation was mainly due to oxaloacetate complexes[5]; thermodynamic association constants for yttrium and dysprosium oxaloacetates are nearly equal[7].

The carbon-13 isotope effects for oxaloacetic acid and for yttrium oxaloacetate are close to those previously observed for decarboxylation reactions, taking into account the observed dependence on temperature[6]. The carbon-13 isotope effect for dysprosium oxaloacetate is very considerably higher. The dysprosium ion is known to cause an acceleration in the rate of fission of $^{13}C-^{13}C$ bonds specifically by virtue of its unpaired $4f$ electrons[4,5]. A comparison of the isotope effects we have found shows that the paramagnetic dysprosium ion catalyses the fission of $^{13}C-^{13}C$ bonds about 4 per cent more strongly than the fission of $^{12}C-^{13}C$ bonds.

One possible interpretation of this 'magnetic' isotope effect is that carbon-13 nuclear spin – electron spin interactions are of the same order of magnitude as the electron spin – electron spin interactions produced at a greater distance by the paramagnetic ion. The effect of the paramagnetic dysprosium ion will then be greater on $^{12}C-^{13}C$ bonds than on $^{13}C-^{13}C$ bonds, where the carbon-13 nuclear spin effect will already be operative. Confirmation of this hypothesis will be sought in a series of similar experiments on carbon-14 isotope effects, carbon-14 having zero nuclear spin.

A full account of this work will be published in due course.

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[1] Stevens, W. H., Pepper, J. M., and Lounsbury, M., *J. Chem. Phys.*, **20**, 192 (1952). Yankwich, P. E., *et al.*, *J. Chem. Phys.*, **20**, 344 (1952); cf. *J. Amer. Chem. Soc.*, **76**, 5893 (1954). Jones, W. M., "Ann. Rev. Phys. Chem.", **5**, 91 (1954).
[2] Pitzer, K. S., and Gelles, E., *J. Amer. Chem. Soc.*, **75**, 5132 (1953).
[3] Gelles, E., and Pitzer, K. S., *J. Amer. Chem. Soc.*, **77**, 1974 (1955).
[4] Gelles, E., *Nature*, **176**, 925 (1955).
[5] Gelles, E., and Clayton, J. P., *Trans. Farad. Soc.* (in the press).
[6] Yankwich, P. E., *et al.*, *J. Amer. Chem. Soc.*, **75**, 832, 4178 (1953); **77**, 4513 (1955).
[7] Gelles, E., and Nancollas, G. H., *Trans. Farad. Soc.* (in the press).

Counting Tritiated Water at High Humidities in the Geiger Region

A method for the direct counting of tritiated water in the Geiger region at high humidities would be most useful. Heretofore, tritiated water has been counted in the Geiger region at pressures less than 2 mm.[1]; or the water has been allowed to react with zinc[2], and the resulting hydrogen counted in a Geiger–Müller tube; or the water has been allowed to react with calcium carbide[3] or aluminium carbide[4] to produce acetylene, which could then be counted. Recently, Nilsson and Aniansson[5] developed a flow counter which would operate in the proportional region with high-humidity gas. They attributed their success to the use of gases such as ethane, propane or *n*-butane, which have ionization potentials lower than that of water vapour. I have succeeded in counting in the Geiger region with a high-humidity gas, a 1·3 per cent *iso*butane-in-helium mixture (Nuclear Chicago *Q*-gas) being used as the flow gas.

A brass counter $5\frac{5}{8}$ in. long and $1\frac{11}{16}$ in. inside diameter was built. An 'Amphenol 82–805' 'Teflon'-insulated connector in the closed end of the brass tube served as the high-voltage connector, and also carried a brass rod $\frac{1}{8}$ in. in diameter and $1\frac{3}{8}$ in. long to which was attached the anode—a tungsten wire 4 mils in diameter and $1\frac{1}{2}$ in. long. An opening $\frac{3}{4}$ in. in diameter and $2\frac{5}{8}$ in. from the top of the tube served as a window over which a source of activity could be placed. The metal planchet carrying the activity was sealed to the tube with 'Apiezon-*Q*'. The window looked directly into the middle of the sensitive volume of the tube. The flow gas entered through a copper tube at the top and left through a copper tube at the

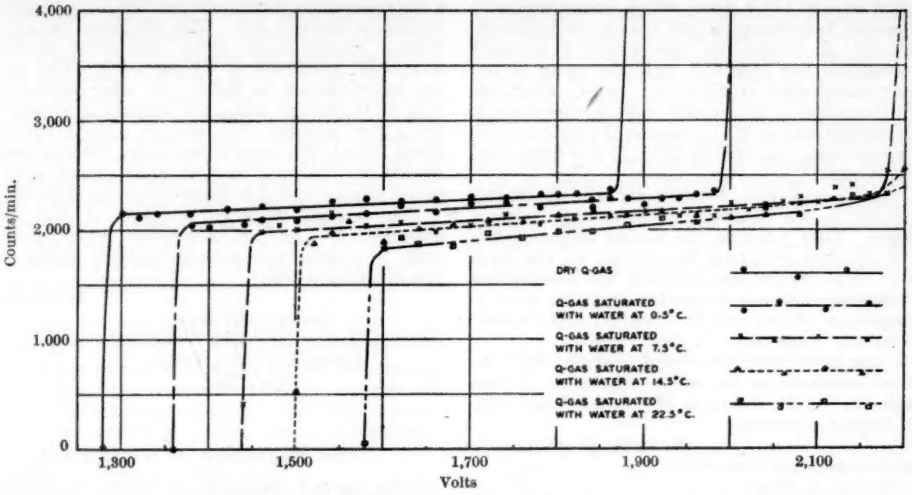

Fig. 1. Geiger plateaux for *Q*-gas containing various amounts of water vapour

bottom of the counter. The bottom of the brass tube was sealed by a metal plate and 'Apiezon-*Q*'.

The *Q*-gas left the storage cylinder through a reducing valve, entered a coil of copper tubing immersed in a Dewar flask, entered a saturator also in the same Dewar, entered another copper coil in a second Dewar, entered the counter, and then escaped through a bubbler which indicated the rate of gas flow. The first Dewar flask was filled with water at the temperature at which it was desired to saturate the gas. The second Dewar contained water at a degree or so below room temperature and served to warm the gas-plus-water vapour back to room temperature.

Sodium-22 in the form of sodium chloride was used as a source of activity. The source contained on a small aluminium planchet was placed over the window of the counter. Table 1 gives the temperatures of the water in the saturator, the vapour pressure of water at these temperatures, and the corresponding relative humidities at a room temperature of 33° C.

Table 1

Dewar 1 temperature, ° C.	Vapour pressure of water (mm. mercury)	Per cent relative humidity (room temperature, 33° C.)
0·5	4·75	12·6
7·5	7·78	20·6
14·5	12·38	32·3
22·0	19·82	52·6

Fig. 1 shows the Geiger plateaux obtained with the 'dry' *Q*-gas and with the gas containing varying quantities of water. The slopes of these plateaux increase as the water vapour in the gas increases. The slope for *Q*-gas alone is 1·64 per cent per 100 V. and that for *Q*-gas at a relative humidity of 52·6 per cent is 3·64 per cent. All of the plateaux are long, ranging from 600 V. to 400 V. The downward displacements and the changes in the slopes of the plateaux are probably caused by a change in the sensitive volume of the tube as a result of the presence of water vapour. The water dipoles apparently modify the electric field between anode and cathode.

0·01 ml. of tritiated water having a specific activity of 10 mc. per ml. was diluted to 10 ml. in a volumetric flask. 5 ml. of this solution was diluted to 10 ml. in a second volumetric flask, etc. A series of five solutions, each differing from the previous one by a factor of $\frac{1}{2}$, was thus prepared. About 3 ml. of a given solution was placed in the saturator, which was then put in the Dewar and brought to 0° C. by means of an ice–water mixture. The voltage on the scaler was set at 1,660 V. *Q*-gas was allowed to flow through the system and counts were taken over successive 5-min. intervals until the counting-rate became constant within the statistical error involved. This process took about one hour. The results are plotted on a relative basis in Fig. 2. The points all lie on a straight line and intersect the zero con-

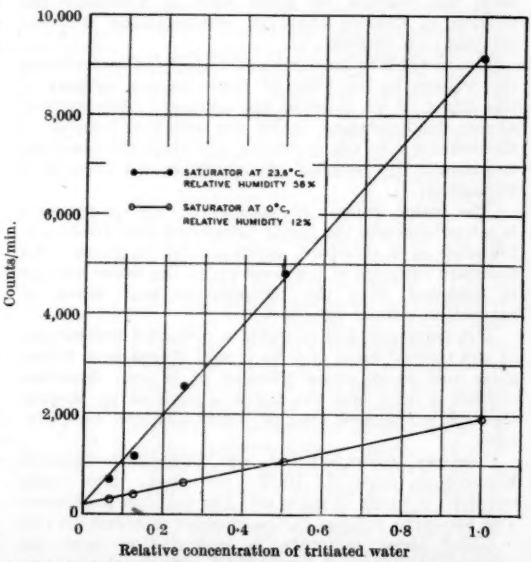

Fig. 2. Linear response of the counter as a function of the concentration of tritiated water

centration axis at 175 c./min., which agrees well with the measured background of 162 c./min., as it should. Another set of results for this series of tritiated water solutions was obtained with the water in the saturator maintained at 23·6° C.; these, which are also plotted in Fig. 2, show much more scatter than do the results obtained at 0° C., because the temperature was not maintained at exactly 23·6° C. but fluctuated about this value.

The results obtained demonstrate the feasibility of counting in the Geiger region at high relative humidities. They point to the almost certain possibility of absolute counting for tritium in the form of THO. The results also indicate the possibilities for the design of counters specifically to be used at high humidities. The paper by Cockroft and Curran[6] is particularly suggestive in this light.

More complete and extensive results will be presented elsewhere as the work progresses. I wish to thank Dr. W. H. Johnson of Purdue University for his helpful comments.

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[1] Pace, N., Kline, L., Schachman, H. K., and Hafenist, M., *J. Biol. Chem.*, **168**, 459 (1947).
[2] Wilzbach K. E., Kaplan, L., and Brown, W. G., *Science*, **118**, 522 (1953).
[3] Wing, J., and Johnston, W. H., *Science*, **121**, 674 (1955).
[4] White, D. F., Campbell, I. G., and Payne, P. R., *Nature*, **166**, 628 (1950).
[5] Nilsson, G., and Aniansson, G., *Nucleonics*, **13**, No. 2, 35 (1955).
[6] Cockroft, A. L., and Curran, S. C., *Rev. Sci. Instr.*, **22**, 37 (1951).

Measurement of Tritium in Water Samples

The concentration of tritium in water samples has been measured by a new method which is both simple and rapid. The beta-rays of very low energy which are emitted by tritium are very difficult to count because of their inability to penetrate the windows of conventional Geiger counters. It has therefore been the practice for some time to introduce the tritium in various chemical combinations into the interior of a counter.

The method to be described consists of introducing the tritium in the form of water vapour as part of the filling of an internal gas counter. Any tritium atoms disintegrating inside the sensitive volume of the counter give rise to counts, and from the observed count-rate the number of tritium atoms present is evaluated.

The water vapour at saturation vapour pressure is introduced and the filling completed with 10–15 cm. pressure of a standard argon–alcohol mixture. An accurate measure of the pressure of the water vapour is obtained from the temperature and tables of saturation vapour pressures.

The argon–alcohol mixture is prepared beforehand in the normal ratio of 9 to 1, and stored in a 5-litre glass bulb at an initial pressure of 30 cm. Absolute alcohol is used and the argon is purified by flowing through a charcoal trap at liquid-nitrogen temperature.

Counters manufactured by Twentieth Century Electronics, type *GA*.10.*M*., are used. The outer envelope is made of glass and the cathode is of steel. The sensitive volume of the counter is about 50 c.c.

Using these counters in conjunction with an external quench unit, type 1014*A*, consistent plateaux are obtained with a length of more than 400 V. and a slope less than 2 per cent per 100 V. The threshold voltage is about 1,400. The efficiency, as compared with a 10-cm. argon filling and using an external source of cobalt-60, is 98 per cent. The counters are not sensitive to light. If, after counting at a rate of 10,000 per min., the counter is pumped only for a few minutes, the residual contamination produces about 200 counts per min. This is easily removed by flushing two or three times with pure water vapour and if necessary heating slightly.

The normal working pressure of the vacuum apparatus is 1 micron, which can easily be obtained with a single-stage rotary vacuum pump and a liquid-nitrogen trap.

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The Reduction of Vitamin B_{12}

Two distinct reduction products of vitamin B_{12} have been described in the literature, by Diehl and Murie[1] and by Boos, Carr and Conn[2]; we shall refer to these as I and II respectively. They differ in their method of preparation, and have widely different absorption spectra in the visible and ultra-violet, but may both be re-oxidized to vitamin B_{12a} by exposure to air, and from polarographic and titrimetric evidence both are claimed to contain divalent cobalt.

Compounds with spectra closely resembling that of I may be obtained by the action of a variety of reducing agents on vitamin B_{12}. Diehl and Murie employed catalytic hydrogenation; but cysteine in alkaline solution, lithium boron hydride, heating in 96 per cent ethanol for 12 hr. at 100° C. in a nitrogen atmosphere, and chromous acetate in aqueous solution, all give similar products, at least initially.

Hydrogenation, using palladium on barium sulphate as catalyst, readily continues beyond the stage represented by I, which in consequence cannot be obtained in a pure state by this method. For this reason, vitamin B_{12a} is obtained in yields of only 60–70 per cent on re-oxidation (Boos *et al.*[2]; Brockman *et al.*[3]). Hydrogenation finally results in visually colourless products with ill-defined ultra-violet absorption; but intermediate compounds with diminished visible colour may also be obtained. On exposure to air, these give brown compounds with spectra somewhat similar to that of I, but which are altered by *p*H changes. They also form reddish cyanide derivatives. They are characterized by rather broad bands in the 435–450 mμ region, and the benziminazole of the nucleotide is no longer co-ordinated to the cobalt, as indicated by the sensitivity[4] of the spectra in the 280 mμ region to *p*H. A very similar sequence is obtained by reduction with lithium boron hydride in aqueous solution. Reduction with chromous acetate in aqueous solution (*p*H c. 5), however, was found to give a solution of I which was stable indefinitely in a hydrogen atmosphere, even in the presence of excess reducing agent. Its spectrum (see Fig. 1) is very similar to that given by Diehl and Murie, and re-oxidation to vitamin B_{12a} appears to be substantially quantitative.

Boos *et al.* obtained II by reduction of vitamin B_{12} in ethylenediaminetetraacetate buffer at *p*H 9·5 with chromous chloride. They observed, however, that the product obtained by the addition of one equivalent

of the chromous salt was brown, whereas II has a characteristic grey-green colour (see Fig. 1). We have reduced vitamin B_{12} in a similar manner, by addition of small amounts of solid chromous acetate to a de-aerated solution of the vitamin in a hydrogen atmosphere, and have found that in ethylenediaminetetraacetate buffer at *p*H 3 the reduction product is exclusively I. At *p*H 9·5 II results if an excess of the reducing agent is used; but I appears as an intermediate product, and with smaller amounts of chromous salt the reduction may be stopped at this stage. The sequence may be reversed by cautious aerial oxidation of a solution of II, which thus appears to be a more highly reduced form of vitamin B_{12} than I.

Both I and II are formed as readily from vitamin B_{12a} as from vitamin B_{12}, and II may also be prepared from a solution of vitamin B_{12} (as the purple dicyanide) in dilute potassium cyanide solution at *p*H 9·5. Its formation does not therefore depend on the presence either of cyanide ion or of ethylenediaminetetraacetate. The oxidation of I by cyanide as described by Diehl is questionable.

The ready re-oxidation of both I and II to vitamin B_{12a} suggests that in both cases the organic part of the molecule has not been significantly affected, and that the changes have concerned the state of oxidation of the cobalt only. In this case the differences between the spectra of I and II are remarkable. That of II even suggests increased conjugation of some kind, possibly resulting from a rearrangement of double bonds, accompanied by release of the benziminazole from co-ordination, as is indicated by increased resolution of the benziminazole fine-structure.

In this connexion it might perhaps be suggested here that the spectrum of vitamin B_{12} may be better accounted for by the addition of one extra double bond to the structures given as alternatives by Crowfoot *et al.*[5] and by Todd and co-workers[6]. The possibility of such an additional double bond is mentioned by Crowfoot *et al.*, and the two alternative structures would then be capable of resonance. The evidence, based on chlorination, in support of the structures as given does not seem sufficiently weighty to rule out completely this possibility. Activated positions susceptible to chlorination still remain in the structures with six conjugated double bonds, and although a further increase in conjugation by elimination of hydrogen chloride cannot then occur so obviously, the spectrum of reduction product II suggests that a long-wave shift of the vitamin B_{12} spectrum may not necessarily require the introduction of additional unsaturation into the molecule.

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[1] Diehl, H., and Murie, R., *Iowa State Coll. J. Sci.*, **27**, 555 (1952). Cf. Jaselskis, B., and Diehl, H., *J. Amer. Chem. Soc.*, **76**, 4345 (1954).
[2] Boos, R. N., Carr, J. E., and Conn, J. B., *Science*, **117**, 603 (1953). See also Schlenker, O., *Helv. Chim. Acta*, **34**, 1356 (1951).
[3] Brockman, jun., J. A., Pierce, J. V., Stokstad, E. L. R., Brognist, H. P., and Jukes, T. H., *J. Amer. Chem. Soc.*, **72**, 1042 (1950).
[4] Beaven, G. H., Holiday, E. R., Johnson, E. A., Ellis, B., and Petrow, V., *J. Pharm. Pharmacol.*, **2**, 733, 944 (1950). Davies, M. T., Mamalis, P., Petrow, V., Sturgeon, B., Beaven, G. H., Holiday, E. R., and Johnson E. A., *ibid.*, **4**, 448 (1952).
[5] Hodgkin, D. C., Pickworth, J., Robertson, J. H., Trueblood, K. N., Prosen, R. J., and White, J. G., *Nature*, **176**, 325 (1955).
[6] Bennett, R., Cannon, J. R., Johnson, A. W., Sutherland, I. Todd, A. R., and Lester Smith, E., *Nature*, **176**, 328 (1955).

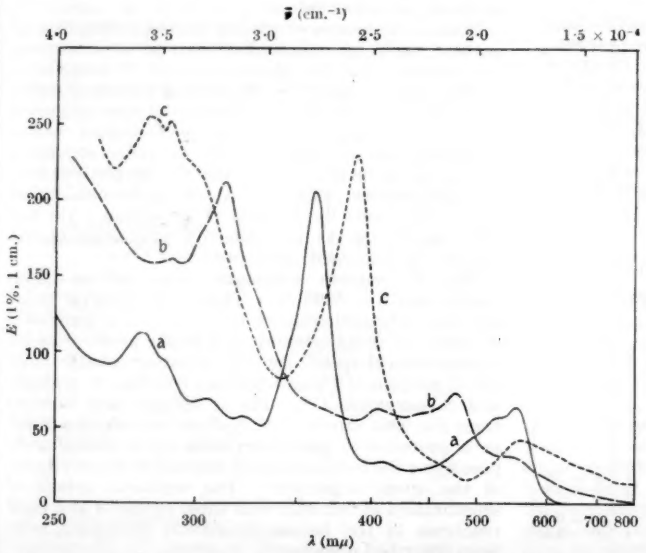

Fig. 1. (*a*) ———, vitamin B_{12} in water; (*b*) — — —, brown reduction product (I); (*c*) - - - - - - -, grey-green reduction product (II). The abscissa is linear in wave-number ($\bar{\nu}$), and the ordinate in extinction coefficient, E(1%, 1 cm.)

Genetic Control of some Serum Proteins in Normal Humans

In a previous communication[1], one of us described the grouping of normal individuals into three groups (I, II*A* and II*B*) on the basis of differences in their serum proteins. A full account of the starch-gel electrophoretic method used for demonstrating these differences and a discussion of the validity of the consequent groupings are now in the press[2]. In these two papers it was suggested that the serum group of a given individual might be fixed and determined by genetic factors.

The distribution of the serum groups in forty-one normal adults unrelated by consanguinity or marriage was found in the earlier work to be: group I, 8; group II*A*, 21; and group II*B*, 12; that is, approximately 1 : 2 : 1. No significant difference was observed in the distribution in males and females. These results suggested to us that the serum group of an individual is controlled by two autosomal genes with incomplete dominance, the frequency of occurrence of the two genes being approximately equal. If this hypothesis is correct, individuals in group I have one type of homozygous combination of genes, those in group II*A* have the heterozygous combination, and those in group II*B* have the other type of homozygous combination of genes.

Table 1

Types of mating	Expected proportions of offspring		
	Group I	Group II*A*	Group II*B*
I × I	1·0	—	—
I × II*A*	0·5	0·5	—
I × II*B*	—	1·0	—
II*A* × II*A*	0·25	0·5	0·25
II*A* × II*B*	—	0·5	0·5
II*B* × II*B*	—	—	1·0

We have therefore commenced a study of families to investigate the hypothesis, and this communication reports on the results obtained so far from eighteen families. It is our intention to increase the number of families to at least fifty; but the results have been sufficiently definite to warrant an interim report on the present smaller number.

Table 1 shows the possible types of matings and the expected frequencies of the offspring among the three serum groups for each mating.

Table 2 shows the results we have obtained from the eighteen families. In every case the offspring were found to have serum groups in complete agreement with the genetic theory, and the observed and expected distribution of the offspring among the three serum groups for all the matings observed were not significantly different. Consequently, on the basis of the eighteen families so far studied, we suggest that the genetic hypothesis here described is correct, and that the serum group of an individual is indeed controlled by two autosomal genes with incomplete dominance.

It will be noted that we have not observed matings of the types I × II*A* and I × II*B*, although the frequencies of occurrence of the three serum groups in unrelated individuals led us to expect five or six of these matings out of eighteen. This may well be a reflexion of the smallness of our present sample; but the possibility of an incompatibility between certain of the groups with a consequent decrease in the fertility of the respective marriages is receiving our attention.

Through the kindness of Dr. Bruce Chown (Children's Hospital, Winnipeg) a determination of the previously known blood groups [*ABO*, *MNS*, *CDE* (*Rh* factor), *K* (Kell), *JK* (Kidd), *Fy* (Duffy), *Le* (Lewis) and *Lu* (Lutheran)] has been made for all individuals comprising the eighteen families so far studied. No direct correlation of any of these blood groups with the new serum groups has been observed. Consequently the medico-legal aspects of the new inherited serum groups will be appreciated, especially as the two genes which control the serum groups occur with approximately equal frequencies.

Table 2

Types of mating	Total matings	Total offspring	Offspring serum groups	I	II*A*	II*B*	
I×I	1	2	Observed	2	0	0	
			Expected	2	0	0	
I×II*A*	0	0	Observed	–	–	–	
			Expected	–	–	–	
I×II*B*	0	0	Observed	–	–	–	
			Expected	–	–	–	
II*A*×II*A*	8	20	Observed	8	8	4	$\chi^2 = 2{\cdot}4$
			Expected	5	10	5	$P = 0{\cdot}3$
II*A*×II*B*	5	8	Observed	0	5	3	$\chi^2 = 0{\cdot}5$
			Expected	0	4	4	$P = 0{\cdot}5$
II*B*×II*B*	4	9	Observed	0	0	9	
			Expected	0	0	9	

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[1] Smithies, O., *Nature*, **175**, 307 (1955).
[2] Smithies, O., *Biochem. J.* (in the press).

Production of 'O Inagglutinability' in Erythrocytes coated with Typhoid Vi and O Antigens

Strains of *Salmonella typhosa* resistant to agglutination by *O* antibody, although containing the characteristic *O* antigen, were observed by Felix and Pitt to be considerably more virulent for mice than strains which were readily agglutinated by *O* antibody. This '*O* inagglutinability' of virulent typhoid cultures was eventually shown by these workers to be associated with the presence of an additional component, the Vi antigen, which had a pronounced effect on the behaviour of the *O* antigen[1].

The phenomenon of '*O* inagglutinability' which led to the discovery of the Vi antigen is the most distinctive and also the most vulnerable property of the Vi antigen of *S. typhosa*. During the past decade, analogous phenomena have been described in certain coliforms and shigella. It therefore seems likely that it is of rather frequent occurrence among enteric species.

The fact that the presence of Vi antigen prevents the agglutination of typhoid bacilli by *O* antibody has been interpreted by some to mean that the Vi antigen is a more superficially located component covering or blanketing the *O* antigen, whereas others favour the view that the Vi antigen so affects the bacterial surface that, by steric hindrance, union of the *O* antigen, also at the cell surface, with its own antibody is prevented.

During the course of studies on the interaction of purified bacterial polysaccharides and erythrocytes, we observed that the phenomenon of '*O* inagglutinability' could readily be reproduced experimentally. Thus when purified Vi and *O* antigens were adsorbed on washed human or sheep erythrocytes either simultaneously or consecutively in either sequence, increasing concentrations of the Vi antigen resulted in a progressive reduction in the agglutinability of the erythrocytes by typhoid *O* antiserum. On the other hand, the Vi agglutinative properties of the suspension remained unaffected.

The Vi antigen employed was isolated from *Escherichia coli* 5396/38. This acidic, highly polymerized polysaccharide is believed to be composed of units of N-acetylamino-hexuronic acid[2]. In its immunological specificity it is indistinguishable from the Vi antigen of *Paracolobactrum ballerup*, *S. typhosa*, and *S. paratyphi* C[2]. The *O* antigen was isolated from the 0901 strain of *S. typhosa* and characterized as a protein-free phosphorylated lipopolysaccharide possessing the immunological and endotoxic attributes of the intact organism[4]. The technical details of sensitization of red cells with these products and their reactions in the hæmagglutination procedure have been described elsewhere[5].

It was reported earlier that erythrocytes could be sensitized with a number of purified bacterial poly-

saccharides either simultaneously or consecutively without discernible interference of one antigen with the activity of any other[6]. However, the concentration of antigens employed (generally 1 μgm. per ml. of 1 per cent red-cell suspension) was only slightly in excess of the amount required for maximal agglutinative activity. In the present study it was observed that when erythrocytes were treated with *O* and Vi antigens, suppression of agglutination by typhoid *O* antibody occurred when the concentration of Vi antigen employed was 10 μgm. or more per ml. of a 1 per cent red-cell suspension. The results of a typical experiment are given in Table 1. Washed erythrocytes were treated with various concentrations of the purified antigens, singly, consecutively or simultaneously, the treated cells washed three times to remove unadsorbed antigen, made up to a 1 per cent suspension, and set up with *O* and Vi antibacterial sera. Inspection of this arrangement shows that concentrations of Vi antigen sufficient to bring about maximal hæmagglutination by Vi antibody have no discernible effect on the typhoid *O* reactivity of these erythrocytes. However, when the amount of Vi antigen employed for sensitization is increased to 10 μgm., a significant reduction in reaction with typhoid *O* antibody occurs. This diminution of *O* agglutinability becomes more pronounced as the quantity of Vi antigen is increased, and at the highest level tested (100 μgm.) the agglutination titre with *O* antiserum was reduced from 1 : 2,560 to 1 : 80. These results indicate that the extent to which erythrocytes treated with *O* antigen react with specific antibody is inversely related to the concentration of Vi antigen to which the cells were exposed.

These findings are in harmony with the early observations of Felix[7] that *O* inagglutinable strains of *S. typhosa* contain the maximum amount of Vi antigen, whereas strains which are readily agglutinated by *O* antibody contain considerably less. Recently, a comparison of the Vi antigen content of the well-known *O* inagglutinable *Ty2* and fully *O* agglutinable '58' strains of *S. typhosa* showed that, in terms of immunogenic potency and the quantity of Vi antigen actually isolated, the *Ty2* strain contained five to ten times as much Vi antigen as the *O* agglutinable strain '58'[8].

Thus the phenomenon of *O* inagglutinability, so well known in typhoid serology, has been in large part duplicated in an experimental model employing erythrocytes and purified Vi and *O* antigens. The interference with *O* agglutination has been shown to be related to the concentration of Vi antigen employed to treat the red cells. These observations provide supporting evidence for the thesis that *O* inagglutinability is an indicator of high or maximal content of Vi antigen in typhoid cultures. They may also be pertinent to the controversy concerning the relative positions of the Vi and *O* antigens on the bacterial surface. The fact that the suppression of *O* agglutinability by Vi antigen occurs regardless of the order in which the Vi and *O* antigens are adsorbed on erythrocytes suggests that '*O* inagglutinability' is not attributable to the 'covering' of the *O* antigen by Vi, but rather is brought about by steric hindrance or a non-specific stabilization of the cell by certain physico-chemical properties peculiar to the Vi antigen. Suppression of agglutination is not restricted to the typhoid *O* antigen adsorbed on red cells, since other bacterial polysaccharides applied to red cells are similarly affected by the Vi antigen. The non-specificity of this blocking action by Vi antigen is further attested in experiments (unpublished results) in which we found that adsorption of Vi antigen on human erythrocytes, in addition to affecting the reaction of other bacterial antigens adsorbed on the red cell, as here described, also suppresses or interferes with blood-group agglutinability, that is, antigens native to the red cell.

Table 1. '*O* INAGGLUTINABILITY' IN BACTERIA AND IN ERYTHROCYTES CONDITIONED BY VI ANTIGEN

Agglutinating systems		Agglutinating antisera (reciprocal of end titres)	
		Anti *O* (*S. typhosa* 0901)	Anti Vi (*P. ballerup*)
Bacterial suspensions			
S. typhosa Ty2 viable		40	320
,, heated 1 hr. at 98° C.		2,560	<20
Erythrocyte suspensions (human, group *A*1) treated with*:			
(*a*) *O* antigen followed by Vi antigen			
10 μgm. *O*	No Vi	2,560	Neg.
,,	1 μgm. Vi	2,560	640
,,	10 ,,	640	640
,,	30 ,,	160	640
,,	100 ,,	80	640
(*b*) Vi antigen followed by *O* antigen			
10 μgm. Vi	No *O*	Neg.	640
10 ,,	10 μgm. *O*	640	640
30 ,,	,,	160	640
100 ,,	,,	80	640
(*c*) Vi and *O* antigens simultaneously			
30 μgm. Vi	10 μgm. *O*	160	640
100 ,,	10 ,,	80	640

* Per ml. of 1 per cent red-cell suspension.

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[1] Felix, A., and Pitt, R. M., *Lancet*, ii, 186 (1934).
[2] Webster, M. E., Clark, W. R., and Freeman, M. E., *Arch. Biochem.*, **50**, 223 (1954).
[3] Landy, M., Webster, M. E., and Sagin, J. F., *J. Immunol.*, **73**, 23 (1954).
[4] Webster, M. E., Sagin, J. F., Landy, M., and Johnson, A. G., *J. Immunol.*, **74**, 455 (1955). Landy, M., Johnson, A. G., Webster, M. E., and Sagin, J. F., *J. Immunol.*, **74**, 466 (1955).
[5] Landy, M., and Lamb, E., *Proc. Soc. Exp. Biol. and Med.*, **82**, 593 (1953).
[6] Landy, M., *Amer. J. Pub. Health*, **44**, 1059 (1954).
[7] Felix, A., *J. Hyg.*, **38**, 750 (1938).
[8] Landy, M., *Amer. J. Hyg.*, **58**, 148 (1953). Webster, M. E., Sagin, J. F., Anderson, P. R., Breese, S. S., Freeman, M. E., and Landy, M., *J. Immunol.*, **73**, 16 (1954).

Fat Production by Inositol-deficient Yeast

THE growth of a yeast (*Saccharomyces cerevisiae*) and a bacterium in mixed culture in a defined medium containing an abnormally low concentration of growth factors has been studied by Challinor and Rose[1], who observed a number of inter-relationships between the two organisms under these conditions. During the continuation of this work, growth of the yeast in a medium in which the concentration of a single growth factor (inositol) was reduced below the normal level was studied, and interesting changes in the morphological and physiological characters of the yeast were observed. Thus, microscopical examination revealed that the deficient cells formed large aggregates and were more granular than normal cells. These differences were clearly seen after two days

growth and became more marked during further incubation. After about three days, the deficient cells were obviously unhealthy in appearance and were easily ruptured, for example, by pressing the coverslip lightly once only. The ease with which rupturing took place increased on further incubation, and after five days very little pressure indeed was required to release the cell contents. A large part of the material so released was oily in nature, and the small droplets coalesced to form large globules which gave typical staining reactions for fats when treated with sudan III and with osmic acid. Normal cells behaved very differently, considerable pressure being required to cause rupture, and then only a proportion of the cells were broken, releasing very little fatty material.

Smith[2] has studied the role of inositol in the nutrition of *S. carlsbergensis*, and he observed that under conditions of inositol-deficiency the yeast grew abnormally, forming aggregates; but he did not comment on the strength of the cell wall or upon fat formation. In view of (1) the apparent high proportion of fatty substances in our deficient cells as compared with the normal cells, and (2) the ease with which these substances were liberated, it was decided to measure the fat production by inositol-deficient cells. Fat production was followed in media containing normal and deficient amounts of inositol, and with ammonium monohydrogen phosphate as the source of nitrogen. The effect of variation of the carbon–nitrogen ratio was studied by reducing the amount of ammonium phosphate to 50 per cent and to 37·5 per cent of the amount in the normal medium. This medium contained: glucose (6 per cent), ammonium hydrogen phosphate (0·237 per cent), adenine, guanine and uracil each 10 μgm./ml., D-biotin 2·2 mμgm./ml., calcium-D-pantothenate 2·5 μgm./ml., thiamine hydrochloride 2 μgm./ml., pyridoxin hydrochloride 2·5 μgm./ml., nicotinic acid 2 μgm./ml., pteroylglutamic acid 0·1 μgm./ml., salts, and inositol 10 μgm./ml. In the deficient media the amount of inositol was reduced to only 0·6 μgm./ml.

The yeast was grown in culture bottles (Glaxo pattern, 2·5 litres capacity; 300 ml. medium per bottle) at 30° C., harvested after five days and the cells ground in a Griffiths tube and dried overnight; the fatty substances were then extracted with 40–60° light petroleum (five consecutive extractions). The yield of fatty substances from the inositol-deficient cells (274 mgm.) was 67 mgm. (24·5 per cent) as compared with only 7·9 mgm. (1·6 per cent) from the normal cells (489 mgm.).

These extractions were carried out at room temperature, and the amount of fat taken out by each extraction was weighed separately so that the ease of extraction from cells grown in the different media could be ascertained. Results indicated that this procedure gave satisfactory extraction from the inositol-deficient cells grown in the medium containing the full amount of ammonium phosphate; but the cells grown in each of the two media containing the reduced amounts of ammonium phosphate did not liberate fat quite so easily and extraction was not quite complete. The yields of fat from the cells grown in each of the latter two media were 60 mgm. (24·7 per cent) and 54 mgm. (22·6 per cent) respectively and, having regard to the above considerations, these yields would not appear to be materially different from that obtained from inositol-deficient cells grown in the medium containing the full amount of ammonium phosphate.

If fat is to be produced commercially from micro-organisms, ease of extraction would be a factor of importance. In view of the ease with which the fat was released from the inositol-deficient yeast, it was decided to extract the cells directly with light petroleum without previous grinding. The yield of fatty substances thus obtained was 59 mgm. (22·3 per cent of the dry weight of the cells), that is, approximately 91 per cent of that extracted from cells which had been ground before extraction. The difference in ease of extraction of the ground and unground cells was therefore small, and it seems likely that it would be narrowed still further by using a higher temperature for the extraction.

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[1] Challinor, S. W., and Rose, A. H., *Nature*, **174**, 877 (1954).
[2] Smith, R. H., *J Gen. Microbiol.*, **5**, 772 (1951).

Autoradiographic Localization of Iodine-131 in the Salivary Glands of the Hamster

The concentration of iodide in human saliva is known to be many times greater than the concentration in the plasma[1]. We have identified the structures associated with a similar iodide-concentrating mechanism in the submaxillary and parotid salivary glands of the hamster. Radioiodide (500 μc. of iodine-131) was injected intraperitoneally into an adult hamster. One hour later, with the animal under ether anæsthesia, the right submaxillary and parotid glands, together with a piece of muscle, were removed and dropped immediately into a vessel containing difluorodichloromethane cooled in liquid air. The frozen tissues were crushed in a mortar cooled in liquid air, and the fragments freeze-dried at − 40°. Contact autoradiographs were then made from sections 7μ thick by a method already described[2]. The concentration of iodine-131 was also measured in portions of the opposite salivary glands, in muscle, and in plasma and saliva removed immediately after the samples were taken for autoradiography. Table 1 shows the ratio of the concentrations of iodine-131 in tissue and plasma in each of the samples.

Table 1

Tissue	Concentration ratio
Submaxillary gland	5·3
Parotid gland	1·7
Muscle	0·4
Saliva	28·0

In sections of the submaxillary gland stained with hæmatoxylin and eosin the ducts could be distinguished by their palely staining cells, and the areas of blackening in the autoradiograph were found to be confined to the ducts. Under high magnification it is possible to distinguish the proximal (acinar) parts of the duct system from the distal ones. Proximally, the lumen is inconspicuous and the lining cells are tall with basal nuclei, whereas the distal part has a wider lumen and is lined by cuboidal cells with central nuclei. Fig. 1*a* shows a branched duct cut longitudinally, with a blood vessel adjacent to it. The intensity of blackening in the autoradiograph (Fig. 1*b*) is no greater over the acini than that over the blood vessel. Blackening is most intense over the proximal portion of the branched duct and over other

ducts in which the proximal part has been cut transversely. Over some of the distal portions of ducts the intensity of blackening is only a little greater than that over blood vessels or acini.

In sections of the parotid gland stained by the periodic acid – Schiff method, two types of ducts can be distinguished (Fig. 2*a*). The proximal portions have a narrow lumen and are lined by dark flat cells, whereas the distal portions have a wide lumen and are lined by large pale cuboidal cells. The pattern of blackening in the autoradiograph (Fig. 2*b*) is seen to correspond with the distal ducts. The intensity of blackening over the acini and over the proximal ducts is no greater than that over blood vessels. The concentration of iodine-131 in the parotid ducts was much less than that in the submaxillary ducts, as judged by the times of exposure needed to give the same degree of blackening in the two sections.

Autoradiographs made from frozen sections of muscle treated in the same way as the sections of submaxillary and parotid glands showed no blackening. Autoradiographs made from frozen sections of submaxillary and parotid, treated with water after alcohol fixation, showed no blackening.

From the pattern of blackening described above, we conclude that the mechanism responsible for concentrating iodide in the saliva of the hamster is present in certain parts of the duct system of the submaxillary and parotid glands. The slight blackening over some of the distal ducts of the submaxillary gland could be explained by the presence of radioactive saliva in the lumen formed farther up the duct, since iodine-131 was shown to be highly concentrated in the saliva. However, we cannot exclude the possibility that the distal parts of the ducts are also able

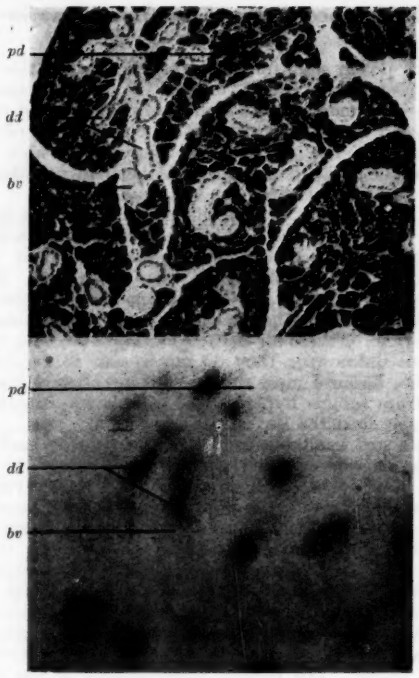

Fig. 2. Hamster parotid gland. (*a*) Stained by periodic acid – Schiff method. (*b*) Autoradiograph of section. *pd*, proximal duct; *dd*, distal duct; *bv*, blood vessel. × 40

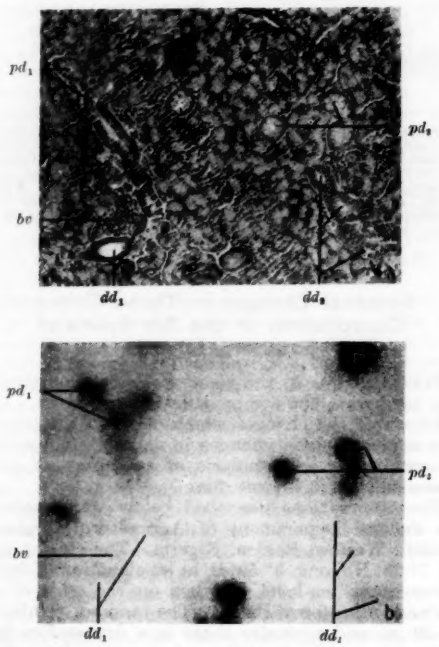

Fig. 1. Hamster submaxillary gland. (*a*) Stained with hæmatoxylin and eosin (black spot is due to a drop of mercury). (*b*) Autoradiograph of section. *pd*, proximal duct; *dd*, distal duct; *bv*, blood vessel. × 80

to concentrate iodide feebly. The blackening over the proximal ducts of the submaxillary gland cannot be due to iodine-131 concentrated in the acini and carried down in the saliva. The concentration of iodine-131 in the plasma of the hamster does not begin to decrease until more than an hour after an intraperitoneal injection. If, therefore, it were continually secreted at a high concentration by the acini and carried down the ducts, the intensity of blackening over the acini would have been at least as great as that over the ducts. By an analogous argument the blackening over the distal parts of the parotid ducts cannot be due to iodine-131 concentrated in the acini or in the Schiff-positive ducts. From the degree of resolution in these sections it is impossible to decide whether the blackening is due to iodine-131 in the cells lining the ducts, in the lumen, or in both. Therefore we cannot say whether the high concentration of iodine-131 in the saliva is due to a direct secretion from the duct cells or to selective reabsorption of water and other solutes from the saliva as it passes down the duct.

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[1] Elmer, A. W., "Iodine Metabolism and Thyroid Function" (Oxford Univ. Press, 1938).

[2] Doniach, I., and Logothetopoulos, J. H., *J. Endocrinol.* [13, 65 (1955)].

Occurrence of the Alga *Gloeocapsa* in the Air

The pollen and fungus spore content of the air has been investigated extensively during recent years in connexion with respiratory allergy and crop diseases. Less is known of other constituents of the air spora. The occurrence of unicellular algæ in the air or in air-borne dust has been demonstrated by several investigators[1].

In quantitative studies of the air spora, we have observed the regular occurrence of a blue-green alga identifiable microscopically as belonging to the Chroococcaceae, probably *Gloeocapsa* (Fig. 1). This is a minute unicellular alga forming loose colonies on moist surfaces, either inland or on the sea-shore. The origin of these air-borne *Gloeocapsa* colonies is at present unknown; they do not appear to be lichen soredia, because most of the colonies observed were free from fungus hyphæ. The mechanism by which they get into the air is also obscure.

Data are available from three centres at each of which air was sampled almost continuously during June 30–July 13, 1954, at a height of 2 metres above ground-level, using the Hirst[2] automatic volumetric spore trap, in which the solid particles in a measured volume of air are deposited in a continuous trace on a slowly moving microscope slide. The deposit on our slides was examined microscopically at distances along the trace corresponding to two-hourly intervals. The areas scanned provided estimates of the number of particles in 12 litres of air for each 2-hr. period. The highest concentration of the alga was observed at Thorney Island, Hants, where an average of 110 colonies per cubic metre of air was recorded over the period of observation. On the roof of the Botany Department, Imperial College of Science and Technology, South Kensington, and in an arable field at Rothamsted Experimental Station, Harpenden, Herts, the average concentration was only 1/20 of that at Thorney Island. Table 1 shows the frequency of occurrence of *Gloeocapsa* colonies in the 12-litre samples, and also the mean and maximum concentration at each centre.

Table 1. Occurrence of *Gloeocapsa* Colonies in the Air during June 30–July 13, 1954

Site	No. of 12-litre samples with *Gloeocapsa*		Concentration per cubic metre of air	
	Present	Absent	Average	Maximum
Thorney Island, Hants	55	95	110	800
South Kensington, London	5	134	7	100
Rothamsted, Harpenden, Herts	7	137	5	100

At Thorney Island the air-borne *Gloeocapsa* colonies averaged about eight cells each. There was a marked diurnal periodicity of occurrence: the maximum at 23.00 hr. averaged 210 colonies per cubic metre, and the minimum, between 04.00 and 13.00 hr., averaged about 30 colonies per cubic metre. Their occurrence was not obviously related to the state of the tide. At Rothamsted and South Kensington, concentrations are known to have been somewhat higher during mid-June 1954 than they were during the period described when sampling was also in progress at Thorney Island.

The concentrations recorded so far are small in comparison with those normal for pollen or fungus spores. They are nevertheless high enough at Thorney Island to indicate that air dispersal may be important in *Gloeocapsa*. With an average concentration of about 800 cells per cubic metre of air for at least three weeks, this organism warrants further study as a potential allergen, especially as the cells of *Gloeocapsa* are embedded in a thick sheath of mucilage.

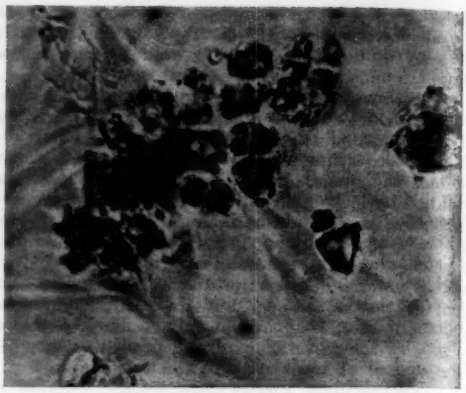

Fig. 1. Group of cells of *Gloeocapsa* type from air sampled at Thorney Island, 21.00 hr., July 6, 1954. × 500 approximately

In connexion with these observations, acknowledgment is made to the Medical Research Council; to the Director of the Meteorological Office for the assistance given by the meteorological staff at R.A.F., Thorney Island; and to Dr. J. M. Hirst, Rothamsted Experimental Station, Harpenden.

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Aug. 27.

[1] Ehrenberg, C. G., "Passat-Staub und Blut-Regen", 192 (Berlin, 1849). Salisbury, J. H., *Amer. J. Med. Sci.*, **51**, 51 (1866). Cunningham, D. D., "Microscopic Examinations of Air", 58 (Calcutta, 1873). Yarwood, A. R., D.S.I.R. "The Investigation of Atmospheric Pollution", 16th Report, 11 (H.M.S.O., 1931). Rempe, H., *Planta*, **27**, 93 (1937). Meier, F. C., *Sci. Mon., New York*, **40**, 5 (1935). Polunin, N., *Svensk. Bot. Tidskr.*, **45**, 320 (1951).

[2] Hirst, J. M., *Ann. App. Biol.*, **39**, 257 (1952).

Seasonal Changes in Three Common Constituents of the Air Spora of Southern Nigeria

Fluctuations in the air spora have been studied in a temperate climate by Hirst[1,2] and others. Less is known of the changes which occur in the tropics. The study of these changes is valuable in assisting the prediction and analysis of epidemics of plant disease due to air-borne fungi.

The observations described below were made at the Federal Department of Agricultural Research, Ibadan, Western Region, Nigeria. The station is at lat. 7° 23′ N., long. 3° 50′ E. at an elevation of 600 ft. above mean sea-level and lies on the edge of the lowland rain forest belt. The annual rainfall is 45–50 in. and typically there is a dry season from December to March and a rainy season from April to November, with a short break during the first half of August. Further details of the vegetation are given by Keay[3] and of the climate by Brooks[4].

The air spora was sampled with an automatic volumetric spore trap sited in the middle of a 7-acre field of close-mown grass. This field is centrally situated within 850 acres of mixed annual and perennial crops. The orifice of the trap was two metres above ground-level.

It was found necessary to modify the methods described by Hirst[3], in order to overcome the effects of high temperature and humidity. The best primer of the microscope slide was 'Solvar 3515'. When applied in a thin film and allowed to dry in a desiccator at laboratory temperature, this priming film was least prone to wrinkling, which has proved to be a troublesome artefact. Ordinary 'Vaseline' when used as an adhesive was found to have too low a melting point, resulting in distortion of the trace. A satisfactory adhesive was B.D.H. Paraffinum molle album, with the addition of 1½ per cent ceresin wax (congealing point 60° C.). This mixture was suitable for use in the high day temperatures experienced and retained good optical properties.

Slides were exposed for periods of 24 hr. and fluctuations in spore concentrations determined by counting 14 mm. traverses at right angles to the long axis of the trace, at distances corresponding to 2-hourly intervals. Counts were expressed as numbers of spores per cubic metre of air. The following spores were studied during both wet and dry seasons:

(*a*) *Puccinia polysora* Underw., a leaf rust of maize the uredospores of which are found in considerable numbers during both wet and dry seasons. (In separating *P. polysora* from other uredospore constituents on the traces, phase contrast was found to be advantageous in recognizing spore numbers and other spore characters.)

(*b*) *Nigrospora sphaerica* (Sacc.) Mason, a dry rot of maize. A common component of the air spora at all times of the year.

(*c*) *Cladosporium* spp., abundant during both wet and dry seasons.

Diurnal periodicities were obtained from counts made over the rainy period April–June 1954, and during the dry months of December 1954–March 1955. In Fig. 1, for comparative purposes, the mathematical treatment is that employed by Hirst[3], periodicities being expressed as percentages of the peak geometrical mean concentrations. The means were calculated from counts made over eighty-seven days in the case of *Puccinia polysora*, and fifty days for both *Nigrospora sphaerica* and *Cladosporium* spp. Corrections for the trapping efficiency of the volumetric trap were applied to *Puccinia polysora* and *Nigrospora sphaerica*. The efficiency of the trap is defined by Gregory[5].

To illustrate the differences in position and size of the peak concentrations of the curves in the wet and dry seasons, the values have been given as the mean peak concentrations of spores per cubic metre of air. This figure was calculated from the average of the daily values of the peak concentration during the wet and dry seasons respectively, and is represented on a logarithmic scale by the vertical lines in Fig. 1.

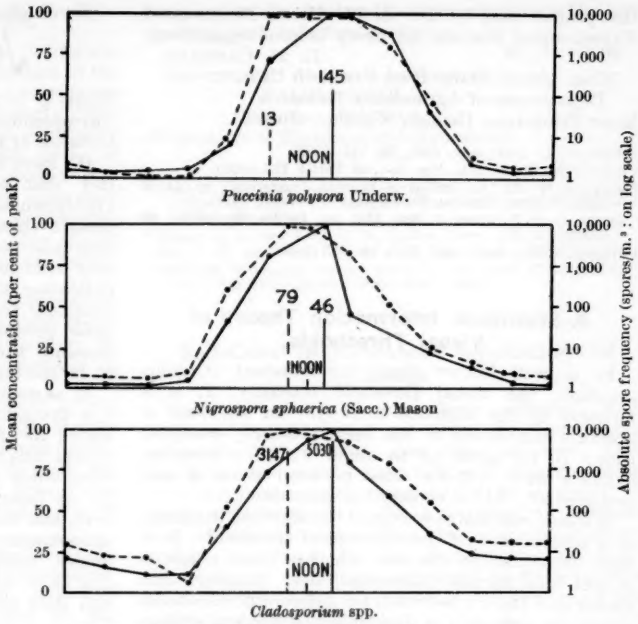

Fig. 1. Mean diurnal periodicity curves of three common constituents of the air spora at Ibadan, Nigeria: ———, wet-season results; – – – –, dry-season results

The general forms of the wet and dry season curves are similar, but peak concentrations occur at an earlier hour of the day during the dry season. This may be due in part to higher temperatures and lower humidities during the dry season, the fall in humidity with rising temperature being more rapid than in the wet season, and consequently minimum relative humidities occur earlier in the day. Highest concentrations of the three spore types mentioned are found under conditions of high temperatures and low humidities coinciding with the peaks of the curves. The wet season curves of *Puccinia polysora* and *Cladosporium* spp. agree generally in form with those obtained by Hirst in Britain for the uredospore group and species of *Cladosporium* respectively.

The absolute values of spore concentrations illustrate that the wet season numbers of *Puccinia polysora* are much higher than those of the dry season, and that *Cladosporium* spp. concentrations are high in both seasons. *Nigrospora sphaerica* is higher in the dry season. The variations in spore numbers depend largely on the availability of hosts in the two seasons as well as on climatic factors, and this is being further investigated.

A correlation of fluctuations in the atmospheric spore load with temperature and humidity values indicates that these variables are two of the more important causal factors influencing the seasonal change in the concentration and diurnal periodicity of the spores mentioned. This will be discussed more fully elsewhere.

Acknowledgments are due to the Director, Federal Department of Agricultural Research, Nigeria, for making facilities for these observations available. I am indebted to Dr. W. R. Stanton for sponsoring

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[1] Hirst, J. M., *Ann. App. Biol.*, **39**, 257 (1952).
[2] Hirst, J. M., *Trans. Brit. Myc. Soc.*, **36**, Part 4, 375 (1953).
[3] Keay, R. W. J., "An Outline of Nigerian Vegetation", pp. 14–23 (Gov. Printer, Nigeria; Crown Agents, London, 1953).
[4] Brooks, C. E. P., *Quart. J. Roy. Met. Soc. London*, **42** (1916); **46** (1920).
[5] Gregory, P. H., *Ann. App. Biol.*, **38**, 357 (1951).

A Statistical Information Theory of Visual Thresholds

It is well known that, for constant stimulus duration, the visual threshold intensity, I, is a function of the stimulus area A. In the case of absolute thresholds it has been generally accepted that: (i) for areas up to about 6′, AI = constant (Ricco's law); (ii) for areas between about 6′ and perhaps 20°, AI^2 = constant (Piper's law).

It seems reasonable to regard the absolute threshold as a special case of the differential threshold. It is then important to discover whether these relations in fact hold for the differential case. Brindley[1] has shown that Piper's law holds for differential thresholds where the test field is discriminated against a large field of constant area. Ricco's law is also found to hold for blue light, optical effects making it difficult to test for other colours. Piper's law for differential threshold where the background area is large and fixed has been formulated:

$$\frac{\Delta I}{I} = \text{const.} \sqrt{\frac{1}{A}} \qquad (1)$$

We find, by using various small background areas, that the more general case where either area is variable may be written, at least approximately,

$$\frac{\Delta I}{I} = \text{const.} \sqrt{\left(\frac{1}{A_1} + \frac{1}{A_2}\right)} + C \qquad (2)$$

This would give the Weber–Fechner law, $\Delta I/I = C$, for very large areas A_1 and A_2, which would make $\left(\frac{1}{A_1} + \frac{1}{A_2}\right)$ negligibly small.

We also find that this may be further generalized to cover low intensities in the region of breakdown of the Weber–Fechner law by adding a small constant thus:

$$\frac{\Delta I}{I + k} = \text{const.} \sqrt{\frac{1}{A_1} + \frac{1}{A_2}} + C \qquad (3)$$

The value of k in terms of equivalent intensity we estimate at about 0·04 ft. l. For the absolute threshold, when $I = 0$, we should then have $\Delta I/k = C$ when the areas are large.

It appears that these, and perhaps other threshold and summation phenomena, may be described in terms of statistical information available in neural information channels. If we suppose that the area A inspected is to be regarded as a set of n independent observations, where n is approximately proportional to A, and that each of these observations is subject to random variation through noise in the system, then for ΔI to be detected against I, in some fixed proportion of the number of trials (for example, an 80 per cent experimental criterion), we must have

$$\frac{[(r + \Delta r) - r] - C}{\sqrt{\left(\frac{1}{A_1} + \frac{1}{A_2}\right) V}} = \text{constant} \qquad (4)$$

where $(r + \Delta r)$, r, are the mean neural pulse-rates corresponding to intensities $I + \Delta I$, I, and V is the variance of neural pulse-rate over the sample.

We have introduced the constant C to explain the fact that few false positives occur in threshold experiments. Without some criterion of difference greater than zero, we should expect about 50 per cent false positives. The proportion of false positives may change with the observer's attitude, or 'set', indicating that C may vary within limits. It is tempting to regard k as arising from the internal noise present in the system, and to think of the absolute threshold as the case where the signal is to be distinguished against noise background.

If, as seems possible from electrophysiological data, r is proportional to $\log (I + k)$, (4) reduces to (3) above for ΔI somewhat less than $I + k$, and we expect this to hold for relatively small values of ΔI even when $I = 0$, that is, for absolute thresholds. In the latter case, as the test area diminishes, however, and the value of ΔI consequently increases, the approximation $\Delta I/k$ used for $[(r + \Delta r) - r]$ is no longer valid, and the more accurate expression $[\log (k + \Delta I) - \log k]$ is required. For A_2 large, (4) can then be written

$$1 + \frac{\Delta I}{k} = \exp (C + \alpha\sqrt{1/A}),$$

writing A for A_1 and denoting the constant involved by α.

For very large A, the terms containing A are negligible; therefore

$$1 + \frac{\Delta I}{k} = \text{const., or } \Delta I = \text{const.} \qquad (5)$$

For smaller A:

$$1 + \frac{\Delta I}{k} = \exp C\,(1 + \alpha/\sqrt{A})$$

or

$$\sqrt{A}\ \Delta I = \text{const.} + \text{const.}\ \sqrt{A} \qquad (6)$$

For even smaller A:

$$1 + \frac{\Delta I}{k} = \exp C \left(1 + \frac{\alpha}{\sqrt{A}} + \frac{\alpha^2}{2A} + \ldots\right) \qquad (7)$$

It thus appears that Ricco's and Piper's laws might be regarded as the different approximations to the logarithmic equation which can be used at different levels. The expression (7) appears to fit Willmer's[2] data satisfactorily. We are undertaking experiments to determine the various constants involved.

Mr. R. T. Leslie, Mr. E. R. F. W. Crossman and Dr. G. S. Brindley have been most helpful in discussing these and related ideas.

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[1] Brindley, G. S., *J. Physiol.*, **124**, 400 (1954).
[2] Willmer, E. N., *Quart. J. Exp. Psychol.*, **2**, Part 2 (May 1950).

Ascorbic Acid Content of Baobab Fruit

In the course of investigations into the nutritional value of traditional African foodstuffs, samples of the fruit of the baobab (*Adansonia digitata* L.) were taken for analysis. This tree, which is particularly noteworthy for the massive girth which its boll eventually attains, is widespread in the low-veld areas of Southern Rhodesia, and the pulp or matrix surrounding the seed in the fruit capsule is commonly chewed or sucked by the indigenous population, or made into a pleasant acidic drink, thus giving rise to the colloquial name of 'cream of tartar' tree.

While there appears to be some difference of opinion regarding the composition of the pulp[1], I have found no recent references in the literature regarding its nutritional value, and it was therefore decided to carry out ascorbic acid assays.

Samples of fruit, which had been collected by the inhabitants, were taken from a kraal in the Kariba gorge area of the Zambesi valley. The fruit was broken open and the seeds and pulp removed. The pulp was scraped from the seeds and ground to give a fine yellow-white powder passing through a B.S.S. No. 60 sieve.

The moisture content was determined and the pulp assayed for ascorbic acid by the 2:6-dichlorophenol-indophenol visual titration method, as originally described by Bessey and King[2], and also by the 2:4-dinitrophenylhydrazine method of Roe and Oesterling[3], in this case determining reduced ascorbic acid, dehydroascorbic acid and diketogulonic acid. In both cases, the technique described by the Association of Vitamin Chemists[4] was followed.

The figures obtained on the pulp were as follows:

Indophenol method:	328 mgm. ascorbic acid/100 gm.
2:4-Dinitrophenylhydrazine method:	307 mgm. ascorbic acid/100 gm.
Moisture content:	11·8 per cent

Fairly reasonable agreement between the methods suggested that no appreciable amounts of interfering substances were present, and that the bulk of the vitamin was present in the reduced form.

The relatively high concentration of ascorbic acid present in the pulp suggested that further investigations be carried out, as the fruit is available where fresh fruit and vegetables are normally difficult to obtain. Further samples of baobab fruit were therefore obtained, in this case from the Sabi Experimental Station. Fruit was collected from ten trees, and the pulp obtained from the fruit of each tree was bulked and prepared for analysis as with the previous sample. No attempt was made to differentiate between the degrees of ripeness of the different fruit capsules.

The analytical figures obtained from the fruit pulp were as follows:

	Ascorbic acid (mgm./100 gm.)	Moisture (per cent)
Minimum	175·0	10·0
Maximum	445·4	13·1
Mean	306·2	10·9

The results confirmed the view that the baobab fruit is an important source of ascorbic acid; and, in fact, the concentration of this vitamin in the baobab is one of the highest in any food in Southern Rhodesia.

Further investigations are in progress to establish the optimum ripeness for maximum ascorbic acid content, and also the stability of the vitamin on keeping, as the fruit is likely to remain on the tree for long periods before dropping.

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[1] Watt, J. M., and Breyer-Brandwijk, M. G., "The Medicinal and Poisonous Plants of Southern Africa" (E. and S. Livingstone, Edinburgh, 1932).
[2] Bessey, O. A., and King, C. G., *J. Biol. Chem.*, **103**, 678 (1933).
[3] Roe, J. H., and Oesterling, M. J., *J. Biol. Chem.*, **152**, 511 (1944).
[4] "Methods of Vitamin Assay", edited by the Assoc. Vitamin Chem., Inc., 2nd edit. (Intersci. Pub., Ltd., 1951).

'Self-Cure' in Nematode Infestations of Sheep

Earlier studies with sheep infested with *Haemonchus contortus* or with *Trichostrongylus colubriformis*[1-3] showed that the 'self-cure' phenomenon was caused by the intake of infective larvæ by sheep rendered hypersensitive as a result of previous infestations. The hypersensitive reaction was evidenced by a transient rise in blood-histamine within four days, by the development of skin-sensitivity to an antigen prepared from larvæ and by the development of œdema in the portion of the alimentary tract infested.

To obtain more direct evidence about the 'self-cure' reaction, selected sheep were anæsthetized by intravenous injection of 'Kemithal', which does not disturb infestations with *H. contortus*, the abomasum was exposed by laparotomy, massive doses of ex-sheathed larvæ were injected into the abomasum, and the reaction of the organ was observed for several hours.

In two worm-free lambs, which had not been exposed to infestation previously, the abomasum remained flaccid and normal for the whole period of observation. In two hypersensitive sheep infested with *H. contortus*, the abomasum showed increased peristalsis and segmentation within 10 min. of injection and, within 1 hr., was pale and œdematous and had contracted in diameter. The reaction commenced to subside in 1½–2 hr. Both sheep showed 'self-cure'; in one the worm egg-count fell from 3,500 eggs per gm. of fæces to 0 in four days, and in the other, from 3,600 eggs per gm. to 400 in seven days. There was no increase in blood-histamine within 4 hr. of the injection of the larvæ. The abomasum was collected from two other hypersensitive sheep at the height of the reaction after the injection of larvæ. No deviation from normal values of histamine could be demonstrated in extracts of the abomasal wall, although the presence of œdema was confirmed by histological examination.

The reaction of several sheep, resistant to *H. contortus*, was examined in the same way and was found to be similar to that of the infested sheep.

It was also reported previously[3] that the intake of *H. contortus* larvæ produced 'self-cure' both of an infestation with the same species or with *T. colubriformis* which infests the duodenum. Further work showed that the intake of *H. contortus* larvæ will also cause 'self-cure' of infestations with other abomasal parasites such as *Ostertagia circumcincta* and *T. axei*, and that the intake of larvæ of these two species will cause 'self-cure' of infestations with *H. contortus* or with *T. colubriformis*.

The direct observation of the abomasum of hypersensitive sheep after the injection of exsheathed larvæ provides further support for the hypothesis that there is a change in environmental conditions at the time of the 'self-cure' reaction. The effect of the intake of larvæ of one species of nematode upon existing infestations with other species appears to depend upon their respective location in the alimentary tract, and again suggests a local rather than a systemic reaction. Antigenic material from larvæ in the abomasum could pass readily to the small intestine, whereas similar material from the small intestine could not pass readily to the abomasum.

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[1] Stewart, D. F., *Aust. J. Agric. Res.*, **1**, 301 (1950).
[2] Stewart, D. F., *Aust. J. Agric. Res.*, **1**, 427 (1950).
[3] Stewart, D. F., *Aust. J. Agric. Res.*, **4**, 100 (1953).

Polygenic Inheritance in *Neurospora*

Ascospores of *Neurospora crassa* two to three times the normal size occur in many strains, though the frequency is low, probably less than one per thousand ascospores. A particular cross made in this laboratory produced an abnormally high frequency of giant ascospores (about 3·4 per cent), and since a number of these germinated and gave good cultures, a study of the phenomenon has been initiated.

Crosses between the cultures derived from these giant spores gave 11·4 per cent giant ascospores, and selection was started from one of these. In each generation giant spores were selected and cultures derived from them were set up as crosses. The successful crosses provided the next generation of ascospores. The response to selection is illustrated in Fig. 1, the frequency of giant ascospores in each generation being based on a sample of more than five hundred ascospores.

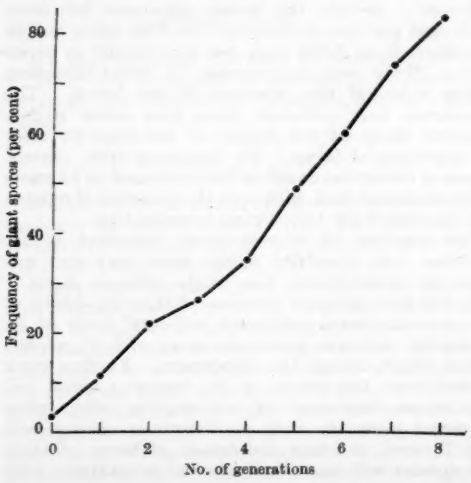

Fig. 1

It should be pointed out that the classification into 'normal' and 'giant' spores is arbitrary. Both types vary, and during the course of the experiment the average size of both classes has increased. However, the great majority of asci gave either four 'giant' or eight 'normal' ascospores, and this results in a definitely bimodal size distribution. Selection has also changed the number of spores maturing in the asci. At the beginning of the experiment most asci contained eight mature, 'normal' spores; in the few asci which gave four 'giant' spores, only one spore matured, the rest of each ascus aborting. In later generations, asci with two, three and four mature 'giant' ascospores occurred. By the eighth generation the frequency of asci containing four mature 'giant' spores approached one per perithecium, and asci containing eight mature 'normal' spores were rare. No asci have been seen with more than four 'giant' spores. A few asci have been seen with spores of both types.

In the third generation, reciprocal crosses were made with a wild-type strain. The resulting asci were all normal. Thus the eight-spored character is 'dominant' to the four-spored, and the size of ascospore and type of ascus apparently depend on nuclear and not cytoplasmic factors.

A further cross was set up between a fifth-generation culture and a wild type. Again all the resulting asci contained eight spores, although the ascospores were rather plumper than the usual wild type. Cultures were derived from a number of these ascospores and crosses set up between them. In this way, twenty-six fertile *F*1 crosses were obtained and samples of ascospores from each of them classified. The results were:

Frequency giant spores (%)	< 1	1-1·9	2-2·9	3-3·9	4-4·9	5-5·9	6-6·9	9-9·9
No. of crosses	13	3	3	2	1	2	1	1

The wide range of frequencies of giant spores from these crosses indicates that a considerable number of genes affecting the frequency of giant spores differentiate the selected and wild-type strains. The steady response to selection also indicates a polygenic character.

Additional evidence is provided by a cross between two strains from the third generation of selection. A normal eight-spored ascus from this cross was dissected in the usual manner into the four different spore pairs. The resulting four cultures were designated 1, 2, 3 and 4 and the four possible crosses were set up between them. The results were:

Cross	Giant spores (%)
1 × 3	12·2
1 × 4	17·0
2 × 3	18·1
2 × 4	21·1

It seems clear that segregation of polygenes affecting the frequency of giant spores occurred during the formation of the dissected ascospores.

One further phenomenon deserves mention: out of 110 giant spores which have so far been cultured, four have been self-fertile and presumably heterozygous for the mating-type alleles. Other markers are being introduced in order to discover if heterozygosity of other loci occurs in these strains.

The analogy between these strains and *N. tetrasperma* is obvious. Dodge[1] showed that in crosses between *N. sitophila* and *N. tetrasperma* the resulting asci were all eight-spored, and that continued backcrossing to *N. tetrasperma* restored the four-spored ascus character. It will be of considerable interest to

see if the present low incidence of homothallic giant spores increases in the future generations of selection. In any event, it seems possible that further investigation of these strains may afford some evidence concerning the usually accepted origin of *N. tetrasperma* from an eight-spored form[2].

These strains may prove of experimental value in that they permit the study of a polygenic character in an organism in which ordered tetrads may be isolated. A further advantage is that all generations of a selection experiment may be preserved, since the ascospores remain viable for several years.

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[1] Dodge, B. O., *J. Agric. Research*, **36**, 1 (1928).
[2] Dodge, B. O., Singleton, J. R., and Rolnick, A., *Proc. Amer. Phil. Soc.*, **94**, 38 (1950).

Widespread Distribution of Mutant Alleles (t-Alleles) in Populations of Wild House Mice

FOLLOWING the proof that mutant changes at one locus (*t*) occur rather frequently in laboratory stocks of mice kept in the balanced lethal condition[1] T/t^n, we turned our attention to the problem whether such mutations are to be found also in wild populations. In the laboratory we had detected such mutations only in stocks which already contained a *t*-allele at this locus; stocks containing *T* (brachyury = short tail) had been under continuous observation in the laboratory since 1932, but no occurrence of mutation to a *t*-allele (revealed by the tailless condition T/t^n) had been detected. Seven different *t*-alleles were detected and isolated[1] by testing the rare normal-tailed exceptions which were found after inbreeding the balanced-lethal tailless stock T/t^1. All such exceptions proved to be t^1/t^x, t^x being a new allele at this locus. This suggested that t^x had arisen either by recombination or rearrangement at the complex locus *t* (Dunn, 1954) or that t^1 had induced mutation to a new allele. The fact that the new mutants were different from t^1 and from each other and that no recombination gametes containing the normal allele (+) were found was taken as evidence against the recombination hypothesis. The locus thus appeared to be unstable in the balanced lethal laboratory stocks. A question of interest was whether there was any evidence of this in wild populations remote from the few laboratories at which *t*-alleles were maintained.

The first tests of this point[2] showed decisively that *t*-alleles are normal components of some wild populations in the United States. Samples of mice caught in the wild were tested by mating them in the laboratory to a standard testing stock $T/+$ (brachy). Some wild mice when so tested produced, in addition to the expected brachy ($T/+$) and normal offspring, tailless offspring which, on further testing, proved to be T/t^n and gave rise to new tailless balanced lines T/t^{w1}, T/t^{w2}, T/t^{w3} and T/t^{w4}. The first three of these alleles were different from each other and from previously known *t*-alleles; the fourth was indistinguishable from a previously known allele t^9. Thus these first wild populations to be tested revealed a variety of alleles, as had the laboratory stocks.

Such tests have now been extended to include samples, usually small ones, from seventeen American populations. In addition, one Japanese population has been tested at the National Institute of Genetics of Japan by crossing with brachy testers ($T/+$) sent from our laboratory and a t^w allele found in three animals. Of these eighteen populations, twelve contained animals heterozygous for a *t*-allele. Each occurrence of tailless offspring from a new population is given a number in the order of discovery. This does not necessarily indicate that the *t*-allele thus revealed is new and different from the others; this can be proved only by crossing balanced lethal lines, each derived from a different population, and such tests have been only partially completed. Of the newer alleles t^{w5} (N.Y. 2) is lethal and different from t^9, t^1, t^6, t^{w1} and t^{w3}; t^{w6} (Florida 1) is lethal and different from t^9, t^1, t^{12}, t^{w1}; and t^{w3}, t^{w5} and t^{w6} cannot be distinguished by the usual test of viability at birth of the compound t^{w5}/t^{w6}. The hypothesis is being tested that this compound, which if found should have a normal tail, dies during embryogeny. t^{w7} (Texas 1) is viable, hence different from t^{w5}, t^{w6} and all previously known lethals, although its difference from other viables (t^2, t^7, t^9, t^{11}, t^{13} and t^{w2}) cannot be directly tested. t^{w8} (Virginia 1) is viable, hence different from any of the lethals. Occurrences t^{w9}–t^{w13} have not yet been tested. These are as follows: t^{w9} (Radford, Virginia) viable; t^{w10} (Misimasen, Japan); t^{w11} (Storrs, Connecticut); t^{w12} (Oakland, California); t^{w13} (El Paso, Texas); t^{w14} (Norwich, Vermont). It is already clear that not all alleles found in the wild are the same, and that many wild populations are polymorphic for this locus.

No single population has been proved not to carry a *t*-allele, since all the negative samples are quite small.

In the populations shown to contain a *t*-allele, the frequency of heterozygotes is very high. Of forty-seven animals tested from such populations, twenty-seven have proved to be heterozygous $+/t^w$. This does not include an extensive sample of ninety-two mice from one such population (*R*3), tested after eight years of inbreeding in the laboratory, in which fifty-two mice were heterozygous; their retention in such high frequency shows that evolutionary forces of some magnitude must oppose their extinction. One of these forces is the altered segregation ratio $t^w : +$ in males, in which the t^w gamete is regularly favoured[3] by ratios of 0·8–0·9. The other may be selection in favour of $+/t^w$, and this is being tested experimentally. A preliminary experiment[4] suggests that $+/t^w$ males may be more fertile than $+/+$.

Many problems remain to be studied with this material. The ubiquity of *t*-alleles in wild populations is taken as proof of their evolutionary significance and justification for further study. Experiments now in progress are designed to test: (1) whether new alleles arise by mutation directly from the normal allele of wild $+/+$ mice (this event has never been detected in laboratory stocks); (2) whether the adaptive value of $+/t^w$ heterozygotes in wild populations differs from that of $+/+$; (3) whether any single wild population contains more than one variety of *t*-allele (no such instance has yet been noted); (4) whether the presence of a particular allele, or the absence of any such allele, bears any relation to the geographical or ecological situation of the population.

This work was carried out at Nevis Biological Station, Irvington-on-Hudson, New York, and since June 1, 1955, under contract *AT*(30–1–1804) U.S. Atomic Energy Commission. Many persons were concerned with collecting mice in the wild and others

with testing them in the laboratory. The co-operation of the former will be acknowledged in more extensive reports. The work depended very much on the skill in handling wild populations in the laboratory of Prof. W. C. Morgan, jun. (now at South Dakota Agricultural College), at the initiation of the experiment, of Mrs. Joan Suckling and Mary Anne Dann during its continuation, and most recently of Dr. Louis Levine, Andrew D. Beasley, Frank Burnett and Robert E. Stephenson, of the Nevis Laboratory.

L. C. Dunn

Zoology Department,
Columbia University,
New York 27.

[1] Dunn, L. C., and Gluecksohn-Waelsch, S., *Genetics*, **38**, 261 (1953).
[2] Dunn, L. C., and Morgan, W. C., *Proc. U.S. Nat. Acad. Sci.*, **39**, 391 (1953).
[3] Dunn, L. C., *Amer. Nat.*, **87**, 327 (1953).
[4] Dunn, L. C., and Suckling, J., *Amer. Nat.*, **89**, 231 (1955).
[5] Schneider, H., *Proc. Soc. Exp. Biol. and Med.*, **63**, 161 (1946).

An Instrument for measuring Soil-Moisture Deficit

The estimation of residual available soil moisture should be an essential part of irrigation practice. Penman's method[1], based on meteorological observations, gives excellent results; but in its present form it is somewhat cumbersome for use by commercial growers. Various alternative methods are available; for example, measured evaporation from an open water surface may be expressed as potential evapotranspiration by means of a suitable conversion factor[1]. Garnier has measured evapo-transpiration directly using a standard grass surface[2]. There is, however, a need for a simple device which will integrate rainfall and evaporation measurements and give a reading expressed as soil-moisture deficit.

We have devised a combined rain-gauge and evaporimeter which ultimately may prove suitable for use by growers for day-to-day control of irrigation. It would also provide valuable data if installed in meteorological stations. The instrument is intended to be placed in a growing crop, so that it collects rain and irrigation water in a common receiver; an evaporation surface, consisting of an unglazed ceramic disk, draws its water supply by capillarity from this receiver. Successful operation of the instrument depends upon correct adjustment of the ratio between the area of the collecting surface and the area of the evaporating surface. The total effective area of the evaporating surface is therefore determined by comparison with a free water surface. This is expressed in terms of area of soil completely covered by plants, using Penman's conversion factor (0·8 for south-east England, March–August). The instrument is then constructed so that the area of its collecting surface equals the area of its evaporating surface thus expressed in terms of plant-covered soil. It is necessary to provide means of adjusting the effective area of evaporating surface to compensate for differences in rate of water-loss between wet soils and dry soils, and between soils completely covered by plants and those only partially covered. An overflow is provided in the receiver at a level corresponding to field capacity, so that any rain which falls when the instrument is indicating field capacity is collected separately and gives a measure of the amount of drainage which has taken place through the soil. The water supply to the evaporating surface is so arranged that when the instrument is indicating wilting point, the water-level in the receiver is just below the level of the outlet, thus cutting off the supply and preventing further evaporation.

When the instrument is correctly adjusted, the amount of water in the receiver at any time corresponds to the amount of water remaining in the soil, so indicating directly the current soil-moisture deficit.

Many workers are carrying out experiments to determine the maximum permissible deficit at various growth stages of the major crop plants. The results of such experiments will enable this instrument to be used for deciding when to irrigate, in addition to indicating how much water is required to restore the soil to field capacity.

G. Stanhill
E. J. Winter

National Vegetable Research Station,
Wellesbourne,
Warwick.
Aug. 17.

[1] Penman, H. L., *Proc. Roy. Soc.*, A, **193**, 120 (1948).
[2] Garnier, B. J., *Nature*, **170**, 286 (1952).

Index of Translations of Foreign Scientific Material

The editorial article in *Nature* of November 19 raises once more the problem of how to ensure that foreign scientific material is economically translated and made available. The index of unpublished scientific translations maintained by Aslib, and covering the principal countries of the Commonwealth, is, I believe, one step in the right direction. May I appeal to readers of *Nature* to help make the index more effective by arranging, whenever possible, for details of partial or complete translation, made or about to be made by their organizations, to be notified systematically to Aslib? The details required are: author, name of periodical, volume, issue number, inclusive pagination, date and translated title, as well as the form of translation (for example, typescript, microfilm, etc.), whether it is complete, partial or a summary, whether it can be bought or borrowed, and the name and address of the holding organization.

Many inquirers now systematically check with Aslib before starting a translation. Their intention to undertake the translation, if one is not known to exist, is recorded at once, so that it is sometimes possible to suggest a joint task with expenses shared to a subsequent inquirer. Last year (the third year of operation) the cost of 137 translations, representing perhaps some £3,000 and possibly unwelcome delays as well, was saved by the index; the figure will doubtless be increased considerably as more firms and institutions collaborate.

The language barrier, however, is only one of many problems in the dissemination of knowledge. Paradoxically, Great Britain spends substantial sums (something like £300 million a year) on research to produce new knowledge, but only trifling amounts on research into ways of putting it where it can be of the widest practical use. Perhaps the time is ripe for the principal organizations representing scientists and information workers to consider jointly how the country's needs in this respect can best be met.

Leslie Wilson

Aslib,
4 Palace Gate,
London, W.8.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, January 3—Wednesday, January 4

INSTITUTE OF PHYSICS, ELECTRON MICROSCOPY GROUP (in the Textile Industries Department, The University, Leeds).—Conference on "The Electron Microscopy of Textile and Other Industrial Fibres".

Tuesday, January 3—Friday, January 6

GEOGRAPHICAL ASSOCIATION (at the London School of Economics and Political Science, Houghton Street, London, W.C.2)—Annual Conference.

Wednesday, January 4

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. P. M. Grundy, Mr. M. J. R. Healy and Mr. D. H. S. Rees: "Economic Choice of the Amount of Experimentation".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. R. L. Brown: "Some Coal Research Problems and their Industrial Implications".*

Wednesday, January 4—Thursday, January 5

PHYSICAL SOCIETY, and the ROYAL METEOROLOGICAL SOCIETY (in the Department of Meteorology, Imperial College, London, S.W.7), at 9.30 a.m. daily—Joint Conference on "Cloud Physics".

Thursday, January 5

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 3 p.m.—Wing Commander R. P. Beamont: "Test Flying—Current Problems and Techniques" (Young People's Lecture).

INSTITUTE OF REFRIGERATION (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. H. H. Egginton: "Refrigeration Controls".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Paper by the late Mr. T. Lawrie on "Highland Water Power—The Development of the North of Scotland Hydro-Electric Board" (the paper will be read by an Officer of the Board).

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. M. B. Martin and Mr. D. L. A. Smith: "Domestic Tape Recording Applications with special reference to Stereophonic Reproduction".

Friday, January 6

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. C. de Duve (University of Louvain): "Intracellular Distribution Patterns of Enzymes".* (Further Lecture on January 9.)

Saturday, January 7

BRITISH MYCOLOGICAL SOCIETY (in the Large Physics Lecture Theatre, Birkbeck College, Malet Street, London, W.C.1), at 11 a.m.—London Meeting.

BRITISH INTERPLANETARY SOCIETY (in the York Hall of Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Dr. H. P. Wilkins: "Evolution of Our Galaxy".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMICAL ENGINEERS (with a good honours degree in chemical engineering or A.R.I.C. or A.M.I.Chem.E., or equivalent qualifications) to investigate plant control techniques, and the technical performance of plant in relation to programming or flowsheeting—The Recruitment Officer, Industrial Group Headquarters, United Kingdom Atomic Energy Authority, Risley, near Warrington, Lancs (January 6).

CHIEF TRAINING OFFICER (with a science or engineering honours degree, and a wide experience with a large industrial organization in the selection and training of scientific and technical staff) to form and operate staff training schemes for professional, scientific and non-technical staff—The Senior Recruitment Officer, United Kingdom Atomic Energy Authority, Risley, near Warrington (January 6).

ASSISTANT LECTURER (with a degree in science or agriculture and an interest in dairy chemistry) IN CHEMISTRY—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (January 10).

ASSISTANT EDUCATIONAL PSYCHOLOGIST (with a degree in psychology and approved clinical training) for duties consisting of advisory work in the schools and diagnostic work in the Hampshire County Council Child Guidance Clinic and Remand Homes—Education Officer, The Castle, Winchester (January 14).

GUIDE LECTURER (with a degree in science or engineering, preferably with lecturing experience and a knowledge of French and German) at the Science Museum, for duties including the preparation and delivery of lectures (with visual aids and practical demonstrations) on the Engineering Sections and to conduct parties round the Museum —Civil Service Commission, Scientific Branch, 20 Old Burlington Street, London, W.1, quoting S.4535/56 (January 14).

ASSISTANT (with a degree in electrical engineering, and preferably with some research or industrial experience) IN THE DEPARTMENT OF ENGINEERING—The Secretary, The University, Edinburgh (January 15).

LECTURER, Grade II (graduate in mining with underground experience and preferably with some research experience) IN COAL MINING—The Registrar, The University, Edgbaston, Birmingham 15 (January 16).

LIVESTOCK RESEARCH OFFICER (Poultry) (with a university degree with emphasis on animal nutrition) at the Poultry Experiment Station, Department of Agriculture, Seven Hills, N.S.W., Australia, to plan and undertake research work in the field of poultry nutrition—The Agent General for New South Wales, 56 Strand, London, W.C.2 (January 24).

LECTURER (with special qualifications in inorganic chemistry, including experience in teaching from elementary level upwards) IN CHEMISTRY in St. Salvator's College—Joint Clerk to the University Court, The University, St. Andrews (January 31).

HEAD OF THE CHEMISTRY DEPARTMENT, Senior Principal Scientific Officer grade—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (February 1).

READER IN EXPERIMENTAL PHYSICS at the Royal Holloway College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 7).

READER IN ZOOLOGY at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 9).

LECTURER or ASSISTANT LECTURER (with a special interest in physico-organic chemistry) IN CHEMISTRY—The Secretary, The University, Exeter (February 11).

LECTURER IN ZOOLOGY—The Secretary, The University, Edinburgh (February 11).

CHAIR OF ELECTRICAL ENGINEERING at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 13).

SENIOR LECTURER or LECTURER IN PHARMACOLOGY at the University College, Ibadan—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (February 13).

READER IN MECHANICAL ENGINEERING at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 14).

READER IN AERONAUTICS at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 16).

ASSISTANT TRIALS OFFICERS (2) (with a degree in botany or agriculture, or equivalent qualification, with practical experience in crop production) to work at the Seale-Hayne Agricultural College, Newton Abbot, Devon, and Leeds University Farm, Headley Hall, Yorks—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

HEAD (with a good degree in zoology and competent to undertake the planning and supervision of the filming and televising of zoological subjects) OF THE TELEVISION AND FILM UNIT, Zoological Society of London and Granada T.V. Network, Ltd.—The Director and Permanent Secretary, The Zoological Society of London, Regent's Park, London, N.W.1.

LABORATORY ASSISTANT (with experience in either physical or biological laboratory work), to assist in research work involving the application of physical methods in biological problems—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks, quoting 55/25.

MASTER to take charge of the Science Department and advise on the building and equipment of new laboratories—The Headmaster, Berkhamsted School, Herts.

PRODUCE OFFICER (with a university degree in agriculture or economics or a national diploma in agriculture, with experience in the handling of agricultural products, particularly grading inspection and storage, and some knowledge of prevention and control of pest infestation of stored products) with the Government of the Northern Region, Nigeria—Crown Agents, 4 Millbank, London, S.W.1, quoting M1B/42896/TA.

RESEARCH ASSISTANT (with an honours degree in metallurgy, physics or chemistry) to the Joseph Lucas Research Fellow, to undertake research on the structure and mechanical properties of electro-deposits—Department of Industrial Metallurgy, The University, Birmingham 15.

RESEARCH OFFICER (with a university degree in forestry, or a university degree in botany and a diploma in forestry) IN THE DEPARTMENT OF FOREST RESEARCH, Federation of Nigeria, to carry out sylvicultural investigation, chiefly in the highest forest regions of the Federation, but with a possibility of work in the savannah regions also—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.61/14/06.

SCIENTIST (with a good degree in chemistry or physics, or equivalent qualification, analytical experience and administrative ability), as a deputy to the Area Chief Scientist, Cannock Chase Area Laboratory, for work covering a wide field involving the analysis of coal, water, mine air and stores testing (oil, etc.)—The Divisional Establishment Officer, National Coal Board, Himley Hall, Dudley, Worcs.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Science Masters' Association. Report of the Sub-Committee on Laboratory Technicians, 1955. Pp. 16. (London: John Murray (Publishers), Ltd., 1955. Published for the Science Masters Association.) 1*s.* 2*d.*, post free. [2110

University of Birmingham Metallurgical Society. Annual Newsletter. Fiftieth Anniversary Edition, 1955. Pp. viii+44. (Birmingham: University of Birmingham Metallurgical Society, 1955.) [2110

Commonwealth Agricultural Bureaux. Notes on Progress in the Agricultural Sciences, 1953–54. Pp. 24. (London: H.M. Stationery Office, 1955.) 2s. net. [2110

Department of Scientific and Industrial Research. Building Research Station. National Building Studies—Research Paper No. 22: Studies in Composite Construction. Part 2: The Interaction of Floors and Beams in Multi-Story Buildings. By Dr. R. H. Wood. Pp. vii+124+8 plates. (London: H.M. Stationery Office, 1955.) 5s. net. [2210

Readers' Guide to Books on Electrical Engineering (New Series—No. 29, August, 1955.) Pp. 35. (London: Library Association, 1955.) 1s. [2510

Institution of Electrical Engineers. List of Members. Part 1: Corporate Members and Companions. Pp. 579. (London: Institution of Electrical Engineers, 1955.) [2510

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1955. No. 4: Chemical Aspects of Oceanography. By Dr. H. Barnes. Pp. ii+29. (London: Royal Institute of Chemistry, 1955.) 4s. 6d. [2510

Agricultural Research Council: Soil Survey Research Board. Report No. 7, 1954. Pp. iv+38. (London: H.M. Stationery Office, 1955.) 4s. 6d. [2510

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 945, Vol. 248 (20 October 1955): The Moments of the Number of Points of a Lattice in a Bounded Set. By C. O. Rogers. Pp. 225–251. 8s. 6d. No. 946, Vol. 248 (20 October 1955): An Assessment of the System of Optimum Coding Used on the Pilot Automatic Computing Engine at the National Physical Laboratory. By J. H. Wilkinson. Pp. 253–281. 9s. (London: Royal Society, 1955.) [2510

Proceedings of the West African International Cacao Research Conference held at the West African Cacao Research Institute, Tafo, Gold Coast, 12th to 16th December, 1953. Pp. vii+100. (London: Crown Agents for Oversea Governments and Administrations, 1955.) 12s. 6d. [2510

Gurr's Quick Reference Laboratory Notes: Directions for Preparing Solutions from Compound Stains. Second edition. Pp. 6. Gurr's Commentary on Current Laboratory Methods. No. 16. (September, 1955.) Pp. 59–62. (London: George T. Gurr, Ltd., 1955.) [2610

The Sources of Animal Behaviour. By Prof. G. P. Wells. (An Inaugural Lecture delivered at University College London, 5 May, 1955.) Pp. 20. (London: H. K. Lewis and Co., Ltd., 1955.) 2s. 6d. [2610

Hull Bulletins of Marine Ecology. Edited by A. C. Hardy and Dr. C. E. Lucas. Vol. 3. Pp. i-ix. (June, 1955): Title Page, Contents Table, List of Personnel, Explanation. (Hull: At the University College, 1955.) 2s. 6d. [2610

Department of Scientific and Industrial Research and Fire Offices' Committee. (Joint Fire Research Organization.) References to Scientific Literature on Fire. Part 7, 1953. By Miss E. M. Shakeshaft and Mrs. B. F. W. Rogowski. Pp. 122. List of Reports etc. published by H.M. Stationery Office and in Technical Journals. (August, 1955.) Pp. 11. (Boreham Wood, Herts: Fire Research Station, 1955.) [2710

Ministry of Agriculture, Fisheries and Food. Report on the Animal Health Services in Great Britain, 1954, including Report of Proceedings under the Diseases of Animals Act, 1950. Pp. iv+106. (London: H.M. Stationery Office, 1955.) 4s. net. [2710

Institute of Personnel Management. Annual Report, 1954–55. Pp. 20. (London: Institute of Personnel Management, 1955.) [2710

Planning. Vol. 21. No. 387 (24 October 1955): Graduates' Jobs. Pp. 193–208. (London: Political and Economic Planning, 1955.) 2s. 6d. [2710

Agricultural Research Institute of Northern Ireland. Twenty-eighth Annual Report, 1954–55. Pp. 37. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1955.) [2810

International Association for the Exchange of Students for Technical Experience. Eighth Annual Report (November, 1955). Pp. 84. (London: International Association for the Exchange of Students for Technical Experience, 1955.) [2810

Queen's University of Belfast. The Anatomy of the Cold War. By Salvador de Madariaga. (Montague Burton Lecture on International Relations, delivered in the Queen's University of Belfast on April 21, 1955.) Pp. 27. (Belfast: Marjory Boyd, Printer to the Queen's University of Belfast, 1955.) 6d. [2810

A Scientist In and Out of the Civil Service. By Sir Henry Tizard. (The Twenty-second Haldane Memorial Lecture delivered at Birkbeck College, London, 9th March 1955.) Pp. 21. (London: Birkbeck College, 1955.) [2810

Other Countries

Giornale di Microbiologia. Vol. 1, No. 1 (Lugio-Agosto, 1955). Pp. 96+10 plates. Abbonamenti: Italia—il volume di sei numeri L. 2500. Estero L. 3000. Numero separato L. 500. (Milano: Casella Postale 3279. Viale Italia 74–76.) [2110

Reports of the Haffkine Institute, Bombay. For the years 1942 and 1943. By Major-General Sir Sahib Singh Sokhey. Pp. ii+60. Annas 6; 6d. For the years 1944–1946. By Major-General Sir Sahib Singh Sokhey. Pp. iii+85. Annas 5; 6d. For the years 1947–1948. By Major-General Sir Sahib Singh Sokhey. Pp. ii+77. Annas 7; 9d. For the year 1949. By Dr. P. M. Wagle. Pp. ii+56. Rs. 1; 1s. 8d. For the year 1950. By Dr. P. M. Wagle. Pp. iii+60. Rs. 2; 4s. For the year 1951. By Dr. P. M. Wagle. Pp. ii+59. Rs. 1/7/–; 2s. 6d. For the year 1952. By Dr. P. M. Wagle. Pp. ii+74. Annas 5; 6d. For the year 1953. By Dr. P. M. Wagle. Pp. iii+88. Annas 7; 9d. (Bombay: Superintendent, Government Printing and Stationery; London: High Commissioner for India, 1948–55.) [2210

Scientific Reports of the Indian Agricultural Research Institute for the year ending 30th June, 1954. Pp. 127. (Delhi: Manager of Publications, 1955.) [2210

Tanganyika: Geological Survey Department. Report No. 1: The Tunduru-Ruvuma Area of the Southern Province—a Reconnaissance of the Geology, Soils, Vegetation and Hydro-electric Potential. By Dr. D. R. Grantham. Pp. iii+14+1 map. Shs. 3. Bulletin No. 24: The Soils of Mbozi (Mbeya District)—a Study in Relation to the Geology and Physiography. By A. M. M. Spurr. Pp. vii+35+4 plates+3 maps. Shs. 7/50. (Dar-es-Salaam: Government Printer, 1955.) [2210

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Technique, No. 45: Le Ravitaillement en Calcium et en Phosphore et le Comportement du Squelette du Bétoil au Congo Belge. Par Prof. L. Hennaux et R. Compère. Pp. 45+6 plates. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1955.) 50 francs. [2210

Chicago Natural History Museum. Fieldiana: Botany. Vol. 29, No. 2: Revision of the Hawaiian Members of the Genus Tetraplasandra A. Gray. By Earl Edward Sherff. (Publication 749.) Pp. ii+49–142. 1.50 dollars. Fieldiana: Anthropology. Vol. 44, No. 2: Old Akkadian Inscriptions in Chicago Natural History Museum—Texts of Legal and Business Interest. By Ignace J. Gebb. (Publication 748.) Pp. iv+161–338. 5 dollars. Fieldiana Zoology. Vol. 37: Karl Patterson Schmidt Anniversary Volume in Honor of his Sixty-fifth Birthday (Publication 747.) Pp. viii+728. 10 dollars. (Chicago: Chicago Natural History Museum, 1955.) [2510

International Scientific Radio Union. Proceedings of the 11th General Assembly held in The Hague from August 23rd to September 2nd 1954. Vol. 10, Part 3: Commission 3 on Ionospheric Radio. Pp. 194. (Bruxelles: International Scientific Radio Union, 1955.) 200 francs; 29s.; 4 dollars. [2510

Shooting Stars. By Prof. Hans Pettersson. Pp. 16. (Särtryck ur Sjöfartsmuseets i Göteborg festskrift för Tor E. J:son Broström, 1955.) [2510

Fisheries Research Board of Canada. Progress Reports of the Atlantic Coast Stations. No. 62 (July, 1955). Pp. 43. General Series Circular No. 26 (July, 1955): Watch for the Green-Crab—a New Clam Enemy. By J. C. Medcof and L. M. Dickie. Pp. 1. (Ottawa: Fisheries Research Board of Canada, 1955.) [2510

British Guiana. Geological Survey Bulletin No. 25: The Geology of British Guiana and the Development of its Mineral Resources. Compiled from Geological Survey Records by G. M. Stockley. Pp. 102+6 plates. (Georgetown: Geological Survey, 1955.) 3 dollars; 12s. 6d. [2510

National Research Council of Egypt. Bulletin of the Scientific and Technical Documentation Centre. Vol. 1, No. 1 (July, 1955): Part 2—Abstracts of Scientific and Technical Papers published in Egypt, and papers received from Afghanistan, Cyprus, Iran, Iraq, Lebanon, Pakistan, Sudan and Syria. Edited with the collaboration of the Unesco Middle East Science Cooperation Office, Cairo. Pp. 13. (Cairo: National Research Council of Egypt, 1955.) [2510

List of Scientific Papers published in the Middle East (Afghanistan, Cyprus, Egypt, Iran, Iraq, Israel, Lebanon, Pakistan, Sudan, Syria and Turkey). No. 12 (July, 1955). Pp. v+130. (Cairo: Middle East Science Cooperation Office, 1955.) [2510

Publicazioni dell' Universita Cattolica del S. Cuore. Nuova Serie. Vol. 51: Annali della Facolta di Agraria—Serie Prima. Pp. vii+498. 4000 lire. Vol. 52: Annoli della Facolta di Agraria—Serie Seconda. Pp. vii+451. 4000 lire. (Milano: Societa Editrice "Vita E. Pensiero", 1955.) [2510

The Carlsberg Foundation's Oceanographical Expedition Round the World, 1928–30, and previous "Dana" Expeditions, under the leadership of the late Prof. J. Schmidt. Dana Report No. 41: The Fishes of the Genus Tetragonurus. By Marion Grey. Pp. 75. (Copenhagen: Andr. Fred. Høst and Son, 1955. Published by the Carlsberg Foundation.) 20 kronor; 20s. [2510

Bechuanaland Protectorate: Geological Survey Department. Annual Report for 1954. Pp. 40. (Lobatsi: Geological Survey, 1955.) 3s. [2610

Provincia de Mocambique. Servicos de Industria e Geologica. Série de Geologica e Minas—Memorias e Communicacoes. Boletim No. 14: Estudos Geoquimicos das Aguas Superficias e Subterraneas das Rochas Sedimentares do Sul do Save. Por Vero Louis Bosazza. Pp. 46+3 plates. (Lourenco Marques: Artes Grafica, Lda., 1954.) [2610

Smithsonian Institution: Bureau of American Ethnology. Bulletin 157: Anthropological Papers Nos. 43–48. Pp. iii+415+76 plates. 2.75 dollars. Bulletin 158: River Basin Survey Papers. Inter-Agency Archeological Salvage Program. No. 7: Archeological Investigations in the Oake Dam Area, South Dakota, 1950–51. By Donald J. Lehmer. Pp. xi+190+22 plates+6 maps. 1.50 dollars. Bulletin 159: The Horse in the Blackfoot Indian Culture, with Comparative Material from Other Western Tribes. By John C. Ewers. Pp. xv+374+17 plates. 2.75 dollars. Bulletin 160: A Ceramic Study of Virginia Archeology. By Clifford Evans. With Appendix—An Analysis of Projectile Points and Large Blades. By C. G. Holland. Pp. viii+195+30 plates. 1.25 dollars. Seventy-first Annual Report, 1953–54. Pp. ii+17. (Washington, D.C.: Government Printing Office, 1955.) [2710

Smithsonian Institution. Freer Gallery of Art. Occasional Papers. Vol. 2, No. 2: Abstracts of Technical Studies in Art and Archaeology, 1943–1952. Compiled by Rutherford J. Gettens and Bertha M. Usilton. (Publication 4176.) Pp. viii+408. (Washington, D.C.: Smithsonian Institution, Freer Gallery of Art, 1955.) [2710

Indian Forest Bulletin (New Series). No. 188: Cellulose and Paper. Indigenous Cellulosic Raw Materials for the Production of Pulp, Paper and Board. Part 23: Chemical Pulps and Writing and Printing Papers from *Saccharum procerum* Roxb. (*Bhutang*). By R. V. Bhat and Marendra S. Jaspal. Pp. ii+9. (Delhi: Manager of Publications, 1955.) 12 annas; 1s. [2710

Forest Research in India, 1950–51. Part 1: The Forest Research Institute. Pp. iii+127. (Delhi: Manager of Publications, 1955.) Rs. 9/8/–; 15s. [2710

Gold Coast Department of Soil and Land-Use Survey. Memoir No. 1: Detailed Soil Survey of the Khong Pilot Irrigation Area. By H. Brammer. Pp. 102+9 maps. (Accra: Government Printer; London: Crown Agents for Oversea Governments and Administrations, 1955.) 10s. [2710

Northern Region of Nigeria. Annual Report of the Forestry Department, 1953–54. Pp. 1+34. (Lagos: Government Printer; London: Crown Agents for Oversea Governments and Administration, 1955.) 9d. [2810